"Second Draft"

EMU OIL:

RESEARCH and DOCUMENTATION COLLATION

PREPARED

by

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TABLE OF CONTENTS.

PREFACE.

This Review of Emu Oil Research and Documentation has been prepared in an effort to collate all relevant publications and emu oil research in one easily retrievable document. It is hoped that as a source of relevant emu oil activities, that it will be updated as and when future publications and research are undertaken.

As I believe that Maria Minnaar in her Emu Farmers Handbook provides the best source of information for anyone either farming emus or doing emu oil research, this dosier is intended to complement that publication. I have included some extracts from Marias book in this collation to demonstrate how comprehensive and readable her book is. Anybody who is working in emu oil research (or farming and marketing emu oil products) should have a copy of this book.

A primary justification for collating this information has been to ensure that we do not waste limited resources duplicating research into emu oil or of researchers wasting time reviewing the literature. At the time of collating the first draft of this review I am an emu farmer. I therefore hope that by undertaking this task in a voluntary capacity and making the information available through our National Association, that it will help to let our industry develop in a cohesive and progressive manner where we are prepared to work together developing the rapidly depleting reserves at our disposal.

Having said that might I also add that in saying this I do not expect that we should all be marketing under one Cooperative, Company or Association. Competition is both healthy and beneficial in providing a greater range of products for a discerning public.

What we all want from shared information and resources though are the same for all of us. We urgently need this information not only to let us develop the indusry but also to enable us to weed out any person or groups misrepresenting the oil. From my point of view the most critical areas include:

1. Identification of the emu oils that do act in accordance with the anecdotal evidence for each of the many attributes claimed. This does not mean that this identification has to be based on the active ingredients as such. Each of these different oils may be identifiable by its chemical composition; chemical structure; or some hitherto unknown source of identification such as force field photography.

2. Development of a guaranteed and reliable test that will be capable of being used to substantiate each of these claims. This test should be capable of being used not only on commercially available products but also in pure rendered oil, unrendered fat but also in live birds.

I believe that if we as an industry can solve these basic challenges then it will be up to us as individuals to see if we can breed for, or manage, our birds to supply whichever oil is the most profitable for each of us. This means that whereas one farm may elect to produce a cheaper low quality oil for the industrial industry, another may concentrate on the more expensive healthcare end of the market.

For the foreseeable future I am happy to be responsible for updating the dosier and ensuring that as this happens a copy of the most recently updated material will always be supplied to the Secretary of the Emu Farmers Association of Australia. As this will always include an adjustment to the document length, the most recent changes will be reflected in the Table of Contents page.

In conclusion, let me say that as much of the material, which appears in this document has been extracted from other journals, books or private sources, I believe that this will prevent this document ever being published. I am taking the view that this material has been collated for my own benefit as part of a requirement for a future doctorate which I will undertake in the future in emu oil research.

In the mean time I am only too happy to share this information with any other person, who is either in a position to undertake this work before me or, who will look at components that will ultimately lead to the satisfaction of the two most pressing industry needs identified above.

To prevent any risk of litigation associated with breach of copyright or similar problems, any material obtained from this dosier must be cited and/or referenced from the original source.

Date: 27 April 1999.

Amendum:

In March 2002 the document was updated by Peter Thompson, so that it could be included as part of an application to the Therapeutic Goods Administration for the "Listing" of emu oil as an Active Ingredient based on Traditional Use. However in the process of preparing the submission the results of the Complementary Medicines Evaluation Committees 35th Meeting held on the 14 June 2002 made the following recommendation to the TGA:

> *"CMEC recommends to the TGA that emu oil is suitable for use as an active ingredient in listable therapeutic goods."*

If this recommendation is accepted by the TGA it means that the next most important phase in ensuring that the anecdotal evidence of emu oils therapeutic qualities are not misrepresented, will depend on the development of a test that will identify the level of therapeutic activity in emu oil.

As there are many things that emu oil is reputed to cure, assist or alleviate this will mean large amounts of research funding and possibly many different tests.

Hopefully the work that has been undertaken at the Womens Childrens Hospital in Adelaide by Professor Ferrante will go some way down this path. By providing a scientifically validated test, it will enable suppliers and users of emu oil products to test the oil that they are buying or selling to check its anti-inflammatory qualities.

Date: 1 August 2002.

INTRODUCTION:

When emus started being farmed in Australia it was largely because of the attributes which Australian aboriginals reported were contained in the emu oil. Further to this it was in fact the aboriginal communities at Wiluna in Western Australia and Cherbourg in Queensland, that were the first places to be granted licenses to farm this protected native Australian species in these states.

Once the farming started there was a massive expansion especially in the eastern states of Australia and at its peak there were around 2,000 licensed emu farmers in Australia.

Unfortunately most of this expansion was based on the potential of the extremely valuable emu oil, healthy lean hi-iron meat and the unique, soft, suptle leather. There were no established markets to take the products and very quickly the "bubble burst". This meant there was an oversupply of emus and birds went from being worth around $2,000.00 for a breeding pair to nothing. The several marketing groups that were established were unsuccessful at developing markets and the research into the value of emu oil was conclusive enough to stimulate demand and large sales of emu oil.

A major tragedy in all of this though was that the aboriginal community that were the first to start farming emus at Wiluna was one of the first casualties. The Cherbourg Community who were the other aboriginal community that started the industry in Queensland are also being forced to get out of the industry as well. This situation is a tragedy as these communities were trying to establish a truelly Australian agricultural enterprise with native Australian species. The farming of these birds is probably more truelly sustainable than any other agricultural land use currently conducted in Australia and now with Mad Cow Disease as a major new disease for food producers over the world to deal with, the farming of emus provides an alternative red meat source that is not susceptible to BSE.

Another contributing factor to the demise of the emu industry was the fact that whilst emu oil has recognised therapeutic qualities, the oil was never registered with the Therapeutic Goods Administration as a "registered" or "Listed" product. This means that people wanting to develop the demand for emu oil are unable to make any claims to the therapeutic value of emu oil. Claims supported by anecdotal and the scientific evidence have so far not been sufficient to get this situation changed.

This compilation is an attempt to reverse that situation. By collating all the evidence, so far published, as well as additional comments collected from people within the industry past and current, it is hoped that the Therapeutic Goods Administration will review their current stand. This submission which is made on behalf of all existing and future emu farmers in Australia. If it is successful it will allow for emu oil to be included as a "Listed" product in the TGA register and as such allow for emu oil products to state that emu oil is an active ingredient in that product.

The documentation starts with an extract from the article by Stephen Davies which appeared in the Australian Emu journal in March/April 1996.

> *"The Research and Information Committee has had two meetings since Dr Desmond Williams published his most useful review of the priorities for research in emu farming. (Australian Emu Nov/Dec 1995)*
>
> *The Committee plans to publish lists of projects from time to time, indicating their status - completed, in progress or proposed - and where information can be found about the results of these investigations a report will be published. In this way we hope to keep members informed and able to find information they may need without too much searching. Here is the first such list (*).*
>
> *We are currently setting priorities for research for 1997 and I shall be glad to hear from any of you about aspects of emu farming that you think could benefit from further research.*

Finally let me pay tribute to the work Dr Williams has done for the Research and Information Committee. In November 1995 he stepped down as Chairman and handed over to me an active and effective committee. Since then I am glad to say that Dr John Dingle of Gatton College, Queensland, has agreed to act as Vice Chairman, so that there is a point of contact for you in the east as well as the west. Please do not hesitate to contact us."

(*) The original list of projects has been edited to only include oil projects.

Unfortunately since this article Stephen Davies is no longer an active member in the emu industry, the Research and Information Committee is non-existent and the Australian Emu Journal ceased publication in 1998.

However in an attempt to follow through with the original intent of the Stephen Davies article, this collation is grouped into several Sections. These are:

1. Emu Oil Research
2. International Emu Oil Standards
3. Bibliography

Appendix: References

1. EMU OIL RESEARCH:

This section of the report contains details of the past, current and future research needs in the emu oil area (Davies 1996).

COMPLETED PROJECTS

Name	**Institute/Person**	**Funding**
Manufacturing oil products	Private Companies	

CURRENT PROJECTS

Develop correct rendering process	WA Dept Ag-Frapple	Current
Set Industry Standard	WA Dept Ag-Frapple	Current
Establishment of all properties & Benefits	WA Ag Dept	Current
Promotional brochure	WA Ag Dept-Inclustry	Current

PROPOSED PROJECTS

Name	**Priority**	**Status Person**
Develop Rendering Process		0
Develop Quality Control		0

Since this time research into other areas has increased and this is detailed in Tables 1 and 2.

TABLE 1: **Past Research**

Topic	*Researcher & Organisation*	*Public/ Private*	*Date &/OR Reference*	*Summary / Abstract*
Anti-inflammatory Activity of Emu Oils in Rats	Snowden JM, and Whitehouse M.W.	Australia - Public	Inflammopharmacology. 1997;5:127-132.	The anti-inflammatory activities of five different preparations of emu (Dromais Novae-Hollandiae) oil, applied topically, have been examined using an experimental polyarthritis in rats. Four of the preparations were found to be active against adjuvant-induced arthriltis in rats, The efficacies of the emu oils acting transdermally are compared with that of orally administered ibuprofen (40 mg,kg).
Oil as a Medicine Carrier	Smith, Paul. C & Craig-Schmidt, Margaret		AEA News, March 1995	
Moisturising and Cosmetic Properties of Emu Oil: A Double Blind Study	Zemstov, Alexander, Gaddis, Monica, and Montalvo-Lugo, Victor		AEA News, October/November 1994	Cosmetic and moisturising properties of emu oil were assessed in a double blind clinical study. Emu oil in comparison to mineral oil was found overall to be more cosmetically acceptable and had better skin penetration/permeability. Furthermore it appears that emu oil in comparison to mineral oil has better moisturising properties, superior texture, and lower incidence of comedogenicity, but probably because of the small sample size these differences were not found to be statistically significant. Neither of the oils were found to be irritating to the skin. Finally emu oil fatty acid composition was studied by gas chromatography and was found to have a high concentration of non polar mono unsaturated fatty acids which may explain emu oil's ability to penetrate easily through the stratum corneum barrier.
Fatty Acid Analysis of Emu Oil.	Dr. Paul Smith, Dr. Margaret Craig-Schmidt, Amanda Brown	AEA funded study, 1994	(Reprinted from AEA News, September 1994 Issue).	Analysis of fatty acids in emu oil reveals that it contains approximately 70 % unsaturated fatty acids. The major fatty acid found in emu oil is oleic acid, which is mono- unsaturated and which comprises over 40 % of the total fatty acid content. Emu oil also contains both of the two essential fatty acids (EFA's) which are important to human health: 20 % linoleic, and 1 - 2 % alpha-linolenic acid.
Fatty Acid Composition: Comparative analysis of emu, ostrich and rhea oil.	Dr. Margaret Craig-Schmidt and K.R. Willian	USA	Abstracts: 88th AOCS Annual Meeting & Expo, Seattle WA, May 1997	A comparison between oil rendered from the fat of the emu, the ostrich and the rhea reveals that the predominant fatty acid in ostrich and rhea oils is palmitic acid, and of emu oil is oleic acid.
International Emu Oil Guidelines	The AEA Oil Standards Team, Lee D. Smith	AEA funded, May 1997	Reprinted from AEA News, Summer 1997	(a) The text part of the Guidelines consists of the Executive Summary, the Introduction, & Background. It gives

	(Team Leader).		issue	the requirements for the handling of emu fat to ensure optimum quality of the finished oil, from bird handling and proc essing to fat handling and cold storage. All farmers, slaughter facilities and processors should have a copy of this text. (b) Actual oil testing criteria are summarized on the Emu Oil Guidelines page. The page is all that would be required by laboratories testing samples of emu oil to make sure the oil satisfies the guidelines for safety & consistency. All oil testing laboratories and oil rendering facilities should have a copy of the Emu Oil Guidelines page.
Emu Oil Processing and Properties	Dr. Ernesto Hernandez at Texas A& M University.	USA	Reprinted from AEA News, November 1995 issue	An outline of the actual processes involved in rendering emu oil from fat, and refining this oil by the RBD process (refining, bleaching and deodorizing).
Processing of Oils for Cosmetic and Pharmaceutical Uses: Applications to Ratite Oil	Dr. Ernesto Hernandez at Texas A & M University	USA	88th American Oil Chemist's Society annual meeting, May 1997. Reprinted from AEA News, Summer 1997	Two different methods for refining oil are outlined: RBD processing, and physical refining. Physical refining uses clay adsorbents rather than chemicals, and may therefore help preserve any biologically active factors in the oil. Th e method chosen will usually depend on what the oil is going to be used for.
Emu Oil: Comedogenicity Testing	Department of Dermatology, at University of Texas Medical School, Houston	Study done for E.R.I., 1993		Testing using rabbit ear histological assay, with emu oil in concentrations of 25%, 75% and 100% shows that emu oil in concentrations of up to 100% is non-comedogenic, i.e. it does not clog the pores of the skin.
Composition of Emu Oil: The Micro View	Leigh Hopkins, AEA Oil Standards Team (Research Leader).	USA	Reprinted from AEA News, Spring 1997 issue	When compared with human skin oil, the fatty acid composition of emu oil is found to be quite similar. In both types of oil, mono-unsaturated oleic acid is the most prevalent fatty acid, followed by palmitic acid, then linoleic acid, which is an EFA (essential fatty acid). This similarity may be one of the factors enabling emu oil to have such a positive action on human skin.

Emu Cream Assists Lidocaine: Local Anesthetic Absorption through Human Skin	Dr. William Code	USA	88th American Oil Chemists Society annual meeting, May 1997. Reprinted from AEA News, Summer 1997 issue	In his initial work with an emu oil based cream combined with spearmint oil and lidocaine, Dr. Code has found that this mixture appears to produce a reduced sensation in the skin as compared with another mixture of local anesthetics w ithout emu oil. The goal is to reduce sensitivity to the skin in a safe, fast and effective way for procedures such as suturing or giving injections.
Experimental Study to Determine the Anti-Arthritic Activity of a New Emu Oil Formulation (EMMP)	Peter Ghosh and Dr. Michael Whitehouse, Australia.	Australia	?? - 1993	A combination of emu oil with a suitable transdermal transporter is found to show anti-inflammatory (anti-rheumatic) activity in various rat models.
Emu Oil: A Source of Non-Toxic Transdermal Anti-Inflammatory Agents in Aboriginal Medicine	Dr. Michael Whitehouse and Athol Turner, Australia	Australia	Inflammopharmacol ogy, San Francisco, March 1997 conference proceedings. Reprinted from AEA News, Summer 1997 issue)	Ongoing studies on the anti-inflammatory activity of emu oils, as tested using the arthritis-induced rat model, indicate that different emu oils vary in their ability to suppress arthritic symptoms and that a chemical test for biolog ical activity is needed rather than continuing to use the rat model.
EM Emu Oil(s): A source of non-toxic transdemal anti-inflammatoryagents in aboriginal medicine	Whitehouse, M.W, Turner, A.G, Davis, C.K, & Roberts M.S)	Australia	Inflammopharmacol ogy, San Francisco,	The 'oil' obtained from emu fat can be a very effective inhibitor of chronic inflammation in rats when applied dermally (with a skin penetration enhancer). Assays for this activity using the adjuvant-induced arthritis model show: (i) considerable variability in potency of some commercial oil samples; (ii) little or no correlation of activity with colour or linolenic acid (18:3) content of the oil; (iii) relative stability of some active oils (to heat, ageing at room temperature); (iv) the bulk of the anti-inflammatory activity was present in a low triglyceride fraction; and (v) potential arthritis-suppressant/immunore gulant activity of these active fractions. These studies point to the need for more rigid quality control beforeconsidering such a (now proven) traditional medicine as a complementary therapy.Repeated applications of selected oils did not induce any of the more prominent side effects associated with NSAIDs (e.g. platelet inhibition, gastrotoxicity) or certain anti-arthritic drugs (proteinuria, leukopenia).

TABLE 2: **Current Research**

Topic	***Researcher & Organisation***	***Public/ Private***	***Date &/OR Reference***	***Cost***	***Summary / Abstract***
Emu Oil Intake Observation	Peter Thompson and Stephen Schmidt	Private	Pers comm (ie Not published)		An observation was undertaken of the effects of emu oil taken orally by 540 mixed age and sex respondents. These respondents were those that responded of the more than 2,000 volunteers, that were given a free three-week supply of emu oil. *The results show that most people have been able to consume emu oil without any short-term negative effects. However there were two of the participants that had to discontinue their involvement in the observation because of the reaction they had to the oil.* This observation shows that as emu oil is a food , which when taken orally has the potential to add to the range of anecdotal attributes reported in the literature. Whilst it would appear that the oil can be taken without short term negative side effects, there will be some people that will react adversely and be unable to consume the oil orally and there are others that will receive no benefit.
	Ferrante et al	Womens Childrens Hospital Adelaide Australia	March 2002		Results not yet published

FUTURE RESEARCH.

There is a desperate need for further research to scientifically substantiate the anecdotal claims which have been made so that emu oil or different emu oils can be identified and registered with the Therapeutic Goods Administration register as a "Registered" product. This will add further weight to the most urgent need of all, which is to get emu included on the TGA Register as a "Listed" active ingredient based on Traditional Use.

For these objectives to be reached future research will need to be conducted in the following areas:

- Cataloguing the diseases which emu oil alleviates or cures;
- Identify the specifications in the oil which assists with these diseases;
- Identification of the rendering technique that will be required to achieve each of these standards;
- Identify with each of these qualities the level of influence of sex, age, nutrition, environment and genetics;
- To identify in live birds those which contain fat which will produce the oil identified in these prior studies;
- To identify heritability in fat qualities;
- To identify the management, rendering and storage regimes required to stabilise emu oil qualities.

There are other areas, which could be added to this list. However these are the most urgent requirements that have to be attended to before the emu industry will be able to reemerge and become a truelly sustainable agricultural alternative farming enterprise.

2. *INTERNATIONAL EMU OIL STANDARDS (Revision 2 - May 1998)*

(Obtained from the Internet)

INTRODUCTION

These Standards are for finished and crude oils. "Finished" oil is defined as oil which has been "refined, bleached and deodorized" by processes generally recognized in the commercial oil industry. All other oils are defined as "crude." The Standards are consistent with results from qualified independent laboratories, members' and non-members' collective experience and judgment, as well as previous work done in Australia.

These Standards were developed by the AEA Oil Standards Team under its mission to "establish industry guidelines and standards to help assure the profitable growth of safe global ratite oils markets." Team members bring broad and relevant experience representing the entire value-adding chain from raising birds to research to sales and marketing. Two members are from Canada, four from Australia, and fourteen from the US. There are two Medical Doctors, a Doctor of Pharmacy, two university professors, and several engineers on the team. And we draw support from a worldwide network of other resources, including the American Oil Chemists Society (AOCS), the international organization for "those with a professional interest in the science and technology of fats, oils, and related substances."

Most of the analytical methods specified are AOCS methods that are standard for the oil industry worldwide. Many of the classical measures that are applied to oils lack specificity such that numerical values will overlap oils from other sources. Taken collectively, however, a fingerprint may emerge that is reasonably unique for emu oil.

Measurements of anti-inflammatory and other forms of activity have yet to be incorporated into the Standards. Activity evaluation is currently under way as an ongoing part of the Team's work - with the full recognition that specifying activity is a far more complex (hence, expensive and lengthy) task than the oil measures contained in the current Standards.

Please note the distinction between "guidelines" and "standards" used in this document:

- Guidelines are those specifications that are based on broad experience in the industry, and, in some cases, data. Guidelines should be followed as if they were standards unless your specific data and experience clearly show a guideline to be inappropriate or unnecessary for your oil.
- Standards are those specifications for which support data are statistically significant or the specification is clearly justified by industry experience. Standards should be met except where a customer expressly requires a different specification. Further, suppliers are encouraged to develop premium and/or specialty oils within the Standards.

The Guidelines cover pre-oil quality and safety considerations.

The Standards are in two sections; a background discussion of all the Standards and the specifications.

Please send questions and feedback to:
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GUIDELINES – PRE-OIL QUALITY and SAFETY CONSIDERATIONS

I. BIRD CONDITIONS

Birds intended for processing into meat and/or oil should be disease-free, healthy birds. They should be raised in an environment which guarantees that products derived from the carcass comply with international standards for freedom from contamination with antibiotics, pesticides, herbicides, heavy metals, worming medicines, growth stimulants, hormones and/or like substances.

II. BIRD PROCESSING CONDITIONS

Birds should be humanely slaughtered in such a way that they are effectively stunned when they are bled.

Electroshock and CO_2 hoods have been used effectively to accomplish humane slaughter.

III. FAT COLLECTION AND STORAGE

Fat should contain a minimum of blood, meat, bone and feathers. Fat should be refrigerated as soon as possible but in any event, within a maximum of two (2) hours after removal from the carcass. If the fat is to be processed more than six (6) hours after removal from the carcass, it should be frozen as soon as possible. Fat to be kept longer than ten (10) days should be stored at -20° F. It is desirable to minimize the thickness of individual packets of fat to assure that the fat is quickly and completely frozen. [Fat in five (5) to fifteen (15) pound sealed plastic bags with one dimension no more than three (3) inches tends to freeze well. Packets should be completely frozen before packing into a larger container.]

IV. EQUIPMENT FOR FAT HANDLING AND OIL PROCESSING

Governmental guidelines for food-grade equipment should be the primary reference for materials of construction and other relevant details. In Australia, consider Australian Quarantine and Inspection Service's "International Code for Storage and Transport of Oils and Fats in Bulk," CAC-RCP 36-1987. In the US, consider USDA's guidelines for sanitary design and fabrication, FSIS Directive 11220.1. In other countries, equivalent codes/standards should be followed. Specifically, materials of construction must be limited to non-reactive materials, e.g., glass, epoxy, etc. Where metals are your choice, ONLY 300 series stainless steels should be used unless your specific experience and analyses show a different metal to be fully acceptable.

STANDARDS – BACKGROUND

I. SOURCE/CONTENT

Adulteration by adding oils from other sources is a potential problem for any valuable oil. Therefore, work will continue on the detection of non-emu oils at very low levels. In any event, it is a basic requirement that the oil has been derived from only emu fat and has not been blended with any other oil.

II. MICROBIOLOGICAL LEVELS

No amount of attention to hygienic conditions can prevent the contamination of the external surface of emu fat. The consequence of the contamination depends on many factors. These factors include, but are not limited to, the following:

1. the specific contaminating organism,
2. the quantity of organisms present in the oil, and
3. how the oil is used.

The fat is best chilled as quickly as is feasible (see Guideline III, "Fat Collection and Storage"). Rapid chilling minimizes enzyme activity that can quickly degrade the fat. And it also minimizes the growth of contaminating organisms.

Microbial growth is aided by the presence of water, nitrogenous nutrients and warm temperatures. Therefore, the choice of processing conditions should be made with this in mind. As the rendering process progresses, water and contaminates tend to be removed from the crude oil. However, unless specific steps are taken to remove the microbial contaminates from the oil, they must be assumed to be present. (Some may choose to hold the oil at 300° F in the absence of oxygen and other reactive materials for one hour to sterilize it. Other methods may also achieve similar results.) Detection of this contamination is made difficult by the very high fat content since most culture media used to grow organisms are water based. Therefore, low level test results for microbial contaminates must be accompanied by process procedures that can assure removal of such contaminates.

While the Standards specify a very low level of microbial contaminates, it is reasonable that some purchasers of emu oil will assume this responsibility. Subsequent formulation manipulations of the oil may present additional opportunities to contaminate the oil. Most of these manipulations will not be done in sterile conditions and this risk also should be managed.

III. WATER (AND OTHER CONTAMINATES)

Generally speaking, conditions that are associated with deterioration of emu oil are water, temperature, oxygen, enzymes, and impurities such as blood and other odor-causing proteins. The presence of any of these materials will accelerate the deterioration processes. But iron oxide (rust) and zinc (from galvanized coatings) are triggers of deterioration as well. Ultra-violet light can also degrade the oil. Even short exposure of the oil to brass or copper can cause the oil to become odorous. All other things being equal, stability increases as water

content decreases. Low water content also minimizes growth of bacteria, yeast, fungus, and mold. Most of these elements are controlled by oil processing conditions. Properly finished oils may be essentially without water through the appropriate combination of temperature, vacuum, agitation, and time.

As with any oil, fatty acids that are the most unsaturated are at the greatest risk of early degradation as water content increases. Usually these fatty acids are also the essential fatty acids, linoleic acid and linolenic acid. (Essential fatty acids are, by definition, those fatty acids that we must obtain from our diet since the body cannot manufacture them.)

IV. APPEARANCE (pending)

Oil generally is white to a light straw color depending on age and feed of the bird. Some oils may have an even darker color.

V. ODOR (specifics pending)

Any objectionable odor has significant negative potential. Pure oil has no objectionable odor, so these problems are the result of contamination of some sort. Proteins with water are the most likely sources. Therefore, efforts to generate oil free of any contamination are crucial.

VI. STABILITY

All animal and vegetable fats/oils are subject to natural degradation processes that can be accelerated by exposure to heat, light and oxygen. The presence of normally occurring substances such as protein and trace metals may also accelerate this degradation. In addition, animal fats naturally contain enzymes whose purpose is to aid in the movement of the fat back into the body's circulation when called upon by energy demands. All of these factors contribute to the cleaving of the fatty acids from the triglycerides. Appropriate refrigeration can substantially reduce the negative effect of all these conditions. Free fatty acids less than 3% are not a stability issue in oil where water and oxygen are at very low levels.

VII. PHYSIO-CHEMICAL CHARACTERIZATION

Several tests are used for this characterization: specific gravity, viscosity, refractive index, iodine value and saponification value. The iodine value measures the quantity of iodine that can be chemically added at the points of unsaturation of the fatty acids. The saponification value measures the quantity of potassium hydroxide that is required to cleave all the fatty acids from the triglycerides. All such measures have a certain degree of uniqueness for individual oils. As with many tests of this nature, there is a lack of specificity such that many oils will have similar or overlapping values. However, deviations outside the ranges provided suggest that the oil may have been adulterated in some manner.

VIII. MAJOR FATTY ACIDS AND IX. MAJOR TRIGLYCERIDES

Fats are a heterogeneous group of compounds that are characterized by their solubility in solvents such as ether and, therefore, they are insoluble in water. Emu oil is rendered primarily from the fat pads of the bird or from what is referred to as the "storage lipids." Emu fat is "storage" fat, as in most animals and organisms, which means it is the principal form of stored energy. As an energy source, it is completely combustible to carbon dioxide and water. This releases a quantity of energy similar to the combustion of a fossil fuel.

This storage fat is fairly simple in its composition. It contains a very small amount of water and cholesterol. (See sections II, III, and X for the importance of the water and sterol contents.) It is essentially 100% triglycerides in composition. A triglyceride is comprised of a glycerin backbone to which three fatty acids are attached. The specific mix of fatty acids is likely to be specie specific. Therefore, the mix of fatty acids is useful information. (Feed and other factors also influence fatty acid mix.) Additionally, the order of attachment of the three fatty acids to the glycerol molecule to form the triglyceride also is likely to be specie specific.

Many of the reported benefits from the applications of emu oil can be broadly classified as involvement in:

- cell structure and function and
- hormonal control.

A discussion of the involvement of fatty acids in the body's chemistry and physiology is beyond the scope of this commentary. Some of the fatty acids play crucial roles as enzyme cofactors, electron carriers, light-absorbing pigments, hydrophobic anchors, emulsifying agents, hormones, and intracellular messengers. Any number of these vital activities, along with the cell structure and functions, may help explain the benefits attributed to the uses of the oil. The AEA Oil Standards Team is seeking a basic understanding of how emu oil contributes to these actions.

X. STEROLS - UNSAPONIFIABLE FRACTION (STEROLS AS A MEASURE OF PURITY)

The sterol fraction is often the larger portion of the unsaponifiable fraction of either animal or vegetable fats. Saponification refers to the chemical reaction that results in the formation of fatty acid soaps. When sodium hydroxide or potassium hydroxide reacts upon fats such as triglycerides, the fatty acid components of the triglycerides are converted to their sodium or potassium salts that are "old time" soaps. The fats, which are not reactive with sodium or potassium hydroxide, are referred to as the unsaponifiable fats. The major portion of the unsaponifiable fraction is the sterols. These are cholesterol and cholesterol-like substances which have a characteristic chemical composition that may simply be described a "closed ring" in contrast to the "chain" or "open ring" appearance of the triglycerides and fatty acids. The cholesterol molecule is the classical "steroid" molecule. This molecule is common to a number of chemicals important to humans; e.g., the anti-inflammatory steroidal hormones such as hydrocortisone, the androgens such as testosterone, the progestogens, the bile acids, vitamin D, and estrogen.

As demonstrated in Tables 1 and 2, the plant sterols are different from the animal sterols. Plants produce mostly sitosterol and very little, if any, cholesterol, with the possible exception of corn oil. (See Table 1.) Therefore, a high level of sitosterol in an oil suggests that at least some of the oil is a vegetable oil. Even though some sitosterol may be ingested by the birds from plant sources or feeds, pure emu oil should have minimal (<50 ppm) sitosterol.

Table 1, Unsaponifiables in Vegetable Oils*

Oil	Total Unsap. (%)	Sterol fraction (%)	Sterols fractionated			
			Sitosterol (%)	Stigmasterol (%)	Compesterol (%)	Cholesterol (%)
Corn	2.0	1.0	66	6	22	2
Cottonseed	0.6	0.4	89	1	5	trace
Olive	0.8	0.1	87	2	2	trace
Safflower	0.6	0.6	52	9	13	-
Soybean	1.2	0.4	52	19	20	trace
Sunflower	0.7	0.4	60	7	8	trace

* Bailey's Industrial Oil & Fat Products, Vol. 1, pg. 404, 1996

NOTE: IN THIS TABLE, a sterol fractionation can be seen as parts per million (ppm) by multiplying its percent by its percent of sterol fraction and then multiplying by 1,000,000; e.g., cottonseed sitosterol at 89% multiplied by cottonseed sterol fraction at 0.4% multiplied by 1,000,000 (0.89 x 0.004 x 1,000,000) = 3560 ppm.

Table 2, Animal Fat Analysis*

Oil	Triglyceride (%)	Triglyceride fractionated					Sterol
		Sat. (%)	Mono. (%)	Poly. (%)	Linoleic (%)	Linolenic (%)	Cholesterol (ppm)
Beef Tallow	100	50	42	4	0.6	3.1	1090
Chicken	68	20	30	15	13	0.7	580
Duck	100	33	50	13	12	1	1000
Goose	100	28	58	11	10	1	1000
Turkey	50	13	22	12	11	0.8	1260
Emu**	**100**	**32**	**51**	**16**	**15**	**0.9**	**< 750**

* Bailey's Industrial Oil & Fat Products, Vol. 1,pg. 464, 1996

** American Emu Association's AEA News, Vol. 5, No. 7 - Fall 1996 (There are reports of some emus showing linolenic acid, C18:3, values as high as 18%.)

STANDARDS – SPECIFICATIONS

I. SOURCE/CONTENT

The oil has only been derived from emu fat and has not been blended with any other oil.

II. MICROBIOLOGICAL LEVELS

For crude and finished oils intended for food and/or pharmaceutical end uses.

Test	Specification	Method
Aerobic microbial count	< 10	AOAC
Combined yeasts and molds	< 10	AOAC

III. WATER

Specification*		Method
Crude	Finished	
< 0.5%	< 0.05%	AOCS, Ca 2c-25

* All other things being equal, stability increases as water content decreases.

IV. APPEARANCE

(See comments under Standards - Background, IV.)

V. ODOR

No objectionable odor. (specifics pending)

VI. STABILITY.

Test	Specification		Method
	Crude	Finished	
Free fatty acids	< 1.5%	< 1.5%	AOCS, Ca 5a-40
Peroxide value	< 25	< 10	AOCS, Cd 8b-90

VII. PHYSIO-CHEMICAL CHARACTERIZATION (crude and finished oils)

Test	Specification	Method
Specific gravity @ 40° C	0.897 - 0.920	AOCS, Cc 10a-25
Viscosity @ 40° C	31 - 43	AOCS, Ja 11-87
Refractive index @ 40° C	1.456 - 1.467	AOCS, Cc 7-25
Saponification value	190 - 200	AOCS, Cd 3-25
Iodine value	65 - 75	AOCS, Cd 1-25

VIII. MAJOR FATTY ACIDS (METHOD: AOCS, Ce 1c-89) (crude and finished oils)

Identity	Name	Mean (%)/1 SD	Range (± 3 SD)
C14:0	Myristic	0.4/0.08	0.17 - 0.68
C16:0	Palmitic	22.0/1.50	17.5 - 26.5
C16:1	Palmitoleic	3.5/0.78	1.2 - 5.7
C18:0	Stearic	9.6/0.80	7.2 - 12.0
C18:1	Oleic	47.4/3.00	38.4 - 56.4
C18:1T	Elaidic*	0.4/0.15	< 1.5
C18:2	Linoleic	15.2/3.00	6.2 - 24.2
C18:3	Linolenic	0.9/0.30	0.1 - 1.8

* Any *trans*-fatty acids present may be related to feed and/or processing.

IX. MAJOR TRIGLYCERIDES (METHOD: HPLC, AOCS Ce 5b-89) (crude and finished oils)

Identity	Name	Mean (%)/1 SD	Range (± 3 SD)
ECN 42	LLL, OLLn, PLLn	1.0/0.5	0.1 - 2.5
ECN 44	OLL, PLL	10.0/2.0	4.0 - 16.0
ECN 46	OOL, POL, SLL	28.2/4.2	15.6 - 40.8
ECN 48	OOO, POO, PPO, SOL	48.2/5.0	33.2 - 63.2
ECN 50	POS	5.8/0.8	3.4 - 8.2

P = palmitic, S = stearic, O = oleic, L = linoleic, Ln = linolenic

X. STEROLS - UNSAPONIFIABLE FRACTION (METHOD: GC/MS) (crude and finished oils)

Name	Specification
Sitosterol	< 50 ppm

3. BIBLIOGRAPHY:

Bennett, G. *Gatherings of a Naturalist in Australasia*, John Van Voorst, London, 1860

Code, W (1997) ***Emu Cream Assists Lidocaine: Local Anesthetic Absorption through Human Skin.*** 88th American Oil Chemists Society annual meeting, May 1997. Reprinted from AEA News, Summer 1997 issue

Craig-Schmidt M and K.R. Willian, K.R. (1997) ***Fatty Acid Composition: Comparative analysis of emu, ostrich and rhea oil.*** Abstracts: 88th AOCS Annual Meeting & Expo, Seattle WA, May 1997

Davies, Max (pers comm). Emu Oil –The Benefits and the Claims.

Davies, Stephen (1996) *Australian Emu* 11:6-8

Ghosh, P and Whitehouse, M.W (1993) ***Experimental Study to Determine the Anti-Arthritic Activity of a New Emu Oil Formulation (EMMP)***

Hernandez, E (1995) ***Emu Oil Processing and Properties.*** AEA News, November 1995

Hobday, C.R. (1994). Emu oil. *Australian Emu* 1:36-37.

Hopkins, L (1997) ***Composition of Emu Oil: The Micro View.*** Reprinted from AEA News, Spring 1997 issue

Johns, J. G, (1996) Oil markets and Marketing. Proceedings World Emu Symposium. Adelaide. Ed. Keogh, K. Hartley Management Group. SOUTH AUSTRALIA.

Johns, J. G, (1996) Oil Production Techniques and Standards. Proceedings World Emu Symposium. Adelaide. Ed. Keogh, K. Hartley Management Group. SOUTH AUSTRALIA.

Leichhardt, L. *Journal of an overland Expedition in Australia, from Moreton Bay to Port Essington, a distance of upwards of 3000 miles, during the years 1844-1845*. T. & W. Boone, London, 1847.

Low, T. *Bush Tucker*. Angus & Robertson, Sydney, 1989.

Minnaar, Maria (1998). The Emu Farmers Handbook. Nyoni Publishing, TEXAS USA.

Smith, P.C and Craig-Schmidt, M. (1995). Fatty acid analysis of Emu oil. *Australian Emu* 4:33-34. (Also in AEA News, September 1994).

Snowden JM, Whitehouse MW. Anti-inflammatory activity of emu oils in rats. Inflammopharmacology. 1997;5:127-132.

Snowden, John (1997). RIRDC Research DAW-82A Milestone 1. EPAV NEWS – 2:6 (4-6).

St George Marketing Solutions. (1997). Marketing Plan for Emu Oil, grade 1 for the Australian Emu Industry. Kinko,s International Australia, SYDNEY.

Thompson, P (1997) Oils Aint Oils. Australian 17:8-9

Whitehouse, Michael (1997) Results of Oil Research. *Australian Emu* 17:8-9.

Whitehouse, M.W, Turner, A.G, Davis, C.K, & Roberts M.S (19??) *EM Emu Oil(s): A source of non-toxic transdermal anti-inflammatoryagents in aboriginal medicine.* . Inflammopharmacology. 19??.

Whitehouse, M.W and Turner A (1997) Inflammopharmacology, San Francisco, March 1997 conference proceedings. Reprinted from AEA News, Summer 1997 issue)

Zemstov, Alexander, Gaddis, Monica, and Montalvo-Lugo, Victor. (1995). Moisturising and cosmetic properties of Emu oil: a double blind study. *Australian Emu* 6:31-33. (Also in AEA News, October/November 1994).

APPENDIX: REFERENCES

NO 1: "OILS AIN'T OILS" (By Peter Thompson.)
Australian Emu – March/April 1997

Hackneyed old phrase that it is and I am sure most of us in the industry have now heard it several times. However so far as emu oil is concerned, I am finding that it really is true. As you will see in the article contributed by Dr Michael Whitehouse (Appendix No 7), the variation in "biological activity" is huge.

Whilst many of us have been aware of this potential, the research that Michael and Craig Davis have been doing over the last few months is most interesting. (I should hasten to add at this point that the good work both of these people have done is voluntary and this cannot continue).

It is for that reason I have asked Michael to provide a brief summary of what has resulted from the tests (these results are only part of the story). We have been processing and selling our own emu products for the last few months, which makes us real beginners in the business. There are a lot of people out there, who are doing and have done much more than us.

However, I suspect that there are not as many people who have actually had a go at rendering their own emu fat! There are many dinner time conversations worth of stories associated with these experiences but 1 will not go into them here! Let me provide you with the most relevant piece of information.

In August last year I had my first lot of birds killed and the fat was sent to Victoria for rendering. In due course a pallet containing several containers of oil was freighted back to me. My initial satisfaction of actually completing the process and value adding the product was short lived.

What did I have? What was it worth? Who buys it? These were only the first questions. They stimulated a whole heap more: What has it been filtered to? What temperature was it rendered at? What is its healing quality? How stable is it? What is its colour, viscosity and smell? etc, etc, etc.

At this point it is also worth mentioning that I knew the history of all the birds that were killed and I had taken samples that were selected from birds of different ages, sex, origin and birds that had been fed on different feeding regimes. These samples were rendered by Craig Davis at the Department of Primary Industries in Queensland and have subsequently been assessed for biological activity by Michael Whitehouse at the Princess Alexander Hospital in Brisbane (Appendix No 15).

Without going into all the rest of the detail here, suffice to say that these samples were rendered at a lower temperature and filtered to a lower micron level than the balance of the fat that was sent to Victoria.

This is not intended as the beginning of an interstate parochial rivalry that I enjoy! I, quite frankly, was completely ignorant of what I wanted from the "renderer" and I still don't know.

However I do know that we have to know!

Therefore, when we started killing our next lot of birds and having a go at rendering our own oil, I engaged the assistance of the Australian "gurus" to provide some help and guidance. This entailed getting Athol Turner from the Sydney University and Michael Whitehouse to come and sort us out

There were many things that came out of that visit but the most important aspects, that I want to include in this article, are the suggested oil standards that Athol believes we should be adopting. In documenting these here I am hopeful that it will provide a basis for discussion that will be aired at the national level rather than with a few of us in a car between Brisbane and "Tjuringa".

To market emu oil, we urgently need some standards that are based on more than a peroxide test I am uncertain as to who takes responsibility for this from here.

However, speaking on behalf of those of us who have spent the money getting Athol to Queensland and are contributing to Michael's research, we really want to see this information published as a basis for discussion and

establishment of some real standards! All credit for the creation of, and suggested modifications to, these "Standards", needs to be directed to Athol Turner and I hope there is plenty of it!

Emu Oil Grades and Specifications:
Currently the trend is to grade oils based on peroxide values with Grade 1 being the best. This does not allow for gradings of high quality oils with specific pharmaceutical, medical and cosmetic potential. To overcome this problem the following suggestions are presented as a basis for discussion:

Label Prerequisites:

- date of rendering;
- volume;
- the temperature that the fat was rendered at;
- whether the fat was internal (gut), external (back) or a mixture of both;
- a peroxide test (and date) to indicate level of rancidity of the oil;
- genetic background (i.e., Queensland or West Australian Origin)
- nutritional regime (i.e., several proprietary mixes with and without access to pasture as well as straight grass)
- sex;
- age;
- native or farmed.

Grades:

Grade	Use	Specifications
1	Raw Oil	Filtered to 25µ (Unstable - See Note # 1)
2	Raw Oil	Filtered to 1µ (Unstable - See Note # 1)
3	Raw Oil	Filtered to 0.2µ (Stable - See Note # 1)
4	Cosmetic	Filtered to 0.2µ plus tests for: Viscosity, clarity specific gravity refractive index, water content fatty acid composition, ester value, acid value, anisedine equivalent of premium olive oil
5	Pharmaceutical	Filtered to 0.2µ plus tests as for Grade 4 oil and a Microbiology test
6	Medical	Filtered to 0.2µ plus tests as for Grade 5 oil and a Biological Activity Test (See Note # 2).

Notes:

1. Oil filtered at less than 0.2µ may contain fungi and/or bacteria, which means that the oil would not be sterile.
2. Any of the grades could have additional tests performed as optional extras. The most logical test is the Biological Activity, which would be undertaken on Grade 1 and 2 Raw Oil to see what potential it had for refinement into the higher grades.
3. All oils should be stored at less than 30^0C, in opaque food or pharmaceutical grade containers and out of sunlight.

This grading system allows farmers to render and market oils before they are processed to the higher grades 4, 5 or 6. Also having a biological activity test undertaken would allow farmers and buyers to determine what potential the oil had for further refinement.

We have also tested oils, which are commercially available in the UK, USA, Canada, and sourced from five Australian States.

In concluding this article I would like to make a special appeal for the industry as a whole to get behind this research. If we are unable to get national funding for the work that needs to be done, individuals, such as those who have so far contributed to this research, will be forced to keep any information obtained to themselves to enable them to be remunerated for their contributions.

NO 2: EMU OIL (By Hobday, G.R.)
Australian Emu - July/August 1994

A CLINICAL APPRAISAL OF THIS NATURAL AND LONG USED PRODUCT

Emu oil comes from the rendered fat of the emu, which is filtered and treated to remove all proteins, bacteria and particulate matter. After this treatment the oil is odourless and either a clear liquid or a cloudy cream dependent on the ambient temperature.

Used for centuries by the Indigenous people of Australia and then by white settlers it has more recently been used in a limited clinical way as an embrocation for muscle and joint problems and for a variety of skin conditions.

It has been frequently tested by government and private laboratories and found to contain a number of fatty acids, ranging from Palmitic to Eicosenoic (C16:0 to C22.0). It contains no steroids or hormones and when suitably treated, no bacteria.

ABORIGINAL DISCOVERY

Although known to have been used by the Aboriginal peoples of Australia for the treatment of muscle and joint pain, anthropological studies have failed to determine for how long. Discussions with Aborigines in Wiluna and elsewhere have determined that the methods of treatment included hanging an emu skin on a tree to collect the oil and wrapping sufferers in a freshly killed skin. In both cases the heat of the sun was used to liquify the emu fat and enhance its absorption qualities.

EARLY SETTLER USAGE

The use of emu oil was among many natural remedies adopted by white settlers from the original inhabitants of Australia. Its use expanded when the efficacy of the oil was realised. It was discovered that emu oil burned and carbonised over 100 C so a "double boiler" method was developed to improve extraction techniques.

Use of emu oil was most prevalent in country areas where it was applied in the treatment of painful joints, bruised and swollen muscles and subcutaneous tissue, burns, and dry skin problems. Also it was widely used to keep leather riding tackle supple in the dry inland areas of Australia and as cooking oil.

Bush legend has it that emu oil penetrates glass. It does not, but stored jars have been found to have a film of oil on the outside due to the meniscus and capillary action of the oil against the glass.

RECENT DEVELOPMENT

The use of emu oil has increased dramatically over the last ten years - initially obtained from the fat of wild birds but now exclusively from farm bred stock. Emu oil products are now available in most pharmacies and department stores in Australia in a range of preparations from pure oil to creams and cosmetics with a variety of additives.

CLINICAL EXPERIENCES

I was initially introduced to emu oil by patients of mine who advocated its use in treating their skin, painful joint and muscle ailments. My immediate concern was to ensure that it was safe to be used . I was aware of the past reputation of emu oil but it is satisfying for me to find that on no occasion over the past ten years, having exposed the oil to over 500 patients, using the oil over lengthy periods, it has been very rare for anyone to report that it had deteriorated or "gone ofC.

Before recommending it I had tests done to identify its content which showed it contained a variety of fatty acids but no hormones or steroids. I had the oil tested for bacterial content and found that in its pure state it grew no organisms. In addition, when made into a moisturiser, which is a mixture of oil, and emulsifier and water, I had the cream challenged with four organisms (Staph Aureus, E Coli, Pseudornonas and Candida Albicans) in increasing quantities and compared with glycerol 10% in Sorbolene. The emu oil cream was found to withstand greater quantities of bacteria before growth took hold. Neither cream contained preservatives for this test.

From clinical experience with emu oil, it became obvious that its two major actions were its anti-inflammatory properties and its ability to penetrate the skin. It also appears to provide some solar protection. How these actions occur and to what extent remains to be discovered.

TEN YEARS OF CLINICAL USAGE

During this period my experience with emu oil has been entirely confined to use on the skin. After advising patients of its experimental nature I have prescribed emu oil for use in three main areas,

- Dry skin problems
- Treatment of muscle aches and pains
- Treatment of wounds which had epithelialised

SKIN

Eczema

Eczema sufferers often complain that the moisturisers available on the market, suck as glycerol 10% in Sorbolene, irritate their skin. I have found that emu oil, or creams made from emu oil, have often been of benefit and provide significant reduction of irritation and inflammation of the skin.

Emu oil does not appear to have the sufficient anti-inflammatory properties for use against inflamed eczema. However it is very useful follow up to steroid treatment. **Keloids**

Massaging emu oil twice daily appears to significantly reduce recent keloid scarring and have an anti-inflammatory action against the formation of keloid tissue. It does not seem to reduce old keloid scarring.

Burns

The use of emu cream or oil immediately in early blistering appears to hold great promise. Although trials have been limited it seems to promote faster healing with less pain and scarring.

Donor Sites in Skin Grafting

I have found that the donor site after skin graf ting benefits from the application of the oil, which appears to reduce pain and promote a less scarred heal.

Psoriasis

To date use of emu oil on psoriasi ' s has not been particularly effective, although some patients have reported some benefit.

JOINTS

The benefit of emu oil on joints to reduce pain, swelling and stiffness is most evident where the joint is close to the skin surface, such as hands, feet, knees and elbows. Deep joints such as the hip do not appear to respond.

Stiff joints, particularly as seen in hands, is one area where massaging emu oil is of considerable benefit. Whether this is due to its anti-inflammatory therefore pain relieving property or whether this is due to another facet of the oil remains to be determined by research.

The method used is to massage oil two or three times a day into the painful area and the use of a compress of oil overnight. The best compress I have made is to use approximately eight thicknesses of ordinary paper tissues folded to the size of the affected area on to which the oil is poured and spread like butter. The compress is backed with a slightly smaller sheet of light plastic.

The compress is then bandaged over the painful area overnight. In practice I have found the oil not to deteriorate and the compress to be re-useable for several days with the daily addition of a little extra oil.

"Growing Pains"

This painful condition usually experienced at 2am. in the knees of six year old children, is caused I believe, by the active growing child over-stretching the ligaments and tendons around the knee. By day, the pump action of movement removes the reactive swelling of the area. At night, however, this swelling builds up, the child moves,

cries from the pain in the joint, causing distress to parents and frequently a visit to the doctor where investigations for arthritis may be done.

To date, as a result of massaging emu oil on the joint prior to the child going to sleep, no parents have returned to say their child is suffering from "growing pains".

Rheumatoid Arthritis
I have not found emu oil to be effective against active arthritis such as rheumatoid arthritis although some colleagues have noticed benefit. This is an area that obviously requires further research.

Bruising and Muscle Pain
Emu oil appears to provide significant benefit to recent bruising and muscle pain where the injury is relatively superficial. The treatment being the massage and compress combination previously described. Similarly, sports related muscle strains have been significantly reduced with a post-exercise emu oil massage. Some trainers and masseurs are using this in preference to other oils, again indicating a superior anti-inflammatory action over commonly used embrocations.

RECENT WOUNDS

Emu oil applied to epithelialised wounds appears to reduce scar tissue formation. Also the anti-inflammatory action seems to soothe wounds after surgery This has been very evident in coronary artery bypass graft operations where the greatest discomfort often comes from the leg from which the vein has been removed. In my experience massaging emu oil onto this area two or three times per day has significantly speeded up the healing process and reduce scarring.

As the emu oil used is sterile there is no concern with using it on any open area. I have encountered no ill effects from using emu oil on open areas such as a partially healed wound or abrasion.

CONCLUSION

Used for centuries by the original inhabitants of Australia, emu oil has reached a point of usage where proper clinical studies need to be done to determine its true place in the medical armamentarium. To date no true experimental work has been done. It is my hope that those skilled in research will take up this challenge and run it as fast as the emu.

NO 3: EMU OIL - THE BENEFITS AND THE CLAIMS (By Max Davies)
? 199?

Introduction

Australia's indigenous people have a close affiliation with the land and use ingredients derived from flora and fauna for the treatment of ailments and injuries. The application of emu oil to assist healing was first documented by G. Bennett 1860 "..a topical embrocation for pain relief from sprains and bruises even in horses and cattle..". The Wiluna community's emu farm 1000 kilometres from Perth in Australia's rugged outback first produced, under Government supervision, emu products for traditional use. In the period 1984-87 the first pure emu oil was refined and marketed. This paper examines the origins & evidence supporting the benefits and claims regarding the use of emu oil for the treatment of arthritis and skin disorders.

Definition

The term "emu oil" refers to oils and preparations containing preparations of oils derived from the Dromals Novae - Hollandiae (the Australian Emu). Emu oil should conform to the standards laid down by the Australian National Food Code for oils for human consumption. "Pure Emu OW' is not blended with mineral, plant or other oil from livestock. It may contain an approved food grade antioxidant at an acceptable level as described in the Australian National Food Code.

Observations & Australian Research

The traditional diets and the application of oils by ancient and modem civilisations are an acceptable reference source. The recorded observations of traditional use by indigenous Australians faded as new western medicines were developed in the nineteenth century. The work of Steve Birkbeck at Wiluna attracted little attention until suggestions of "antiinflammation & unique healing properties" were investigated by Dr George Hobday MD from Brentwood, Western Australia. Dr Hobday conducted the first recorded emu oil trials, in three main areas:

- dry skin problems,
- treatment of muscle aches and pains; and
- treatment of wounds which had epithelialised.

Dr Hobday observed the following benefitted from emu oil applications:

- eczema but not inflammed eczema;
- significantly reduced recent kelold scarring;
- if applied immediately to bum blisters,
- on joints to reduce pain, swelling & stiffness,
- for children's legs with "growing pains"
- to recent bruising & muscle spains., and
- to speed up the healing process and reduce scarring.

On rheumatoid arthritis Dr Hobday reports:

“I have not found emu oil to be effective against active arthritis such as rheumatoid arthritis although some colleagues have noticed benefit. This is an area that obviously requires further research."

In 1985 commercial mixtures of emu and eucalyptus oil were trialled. In 1990 -1992 the following was documented:

A biologically active component of emu oil is useful in pharmaceutical compositions for the treatment of inflammation of environmental and systemic origins. Pharmaceutical compositions including emu oil and dermal transport enhancing compounds are useful topical anti -In fl ammatory treatments.
The transport enhancer can be either methyl, ethyl or isopropropl salicylate either isopropyl, butyl or arnyl alcohol; cineole; eucalyptus oil; tea tree oil; oil of wintergreen or like substances. Cineole, eucalyptus oil, tea tree oil and isopropyl alcohol are preferred.

The **yellow components** of emu oil possess remarkable prophylactic antiinfl ammatory/i mmuno-regul ant activity in addition too the ability to modulate disease (polyarthritis) once initiated.

The purified fractions were found to exhibit extremely potent anti -inflammatory activity.

The potent anti-elastase activity demonstrated could provide an anti degenerative effect on dermal tissues particularity during dermal damage through strong UV radiation (sunburn) occurs.

The anti -Infl ammatc, ry capacity reduces when exposed to ultraviolet light.

The presence of linoleic acid or oleic acid tniglycenides appeared not to be related to the biological activity.

The anti-inflammatory activity and colour can be abolished by chemical oxidation ie. by mixing with benzoyl peroxide in an organic solvent.

Other Australian research concluded:

Emu oil contains very high levels of the fatty acids found in abundance In healthy skin. The replenishment of the triglycerdic and fatty acid levels (called the mantle) of deficient skin helps it to return to normal cell production. The application of certain oils to the skin allows some of the oils to penetrate and maintain the permeability of the cells, normal cell evolution then resumes and improvement in the overall appearance of skin occurs.

Overseas Research

Unfortunately the Australian work has never been widely published and only limited pure research was conducted. The results were however taken-up overseas and interest grew quickly in France and America. The French reports supported the Australian research by concluding that emu oil:

- is antiflammatory,
- promotes cellular regeneration; and
- is deeply penetrating.

The published American research highlights the moisturising benefits of emu oil and the proven capacity of the relative high levels of oleic acid to transport other bloactive compounds within the oil into the skin. -17he absence of phosphos-lipids in emu oil contribute to the penetrating ability as follows:

"Our skin is phospho-lipid deficient. In other words, there's no phosphorus in our skin. If you put anything on your skin that has phosphorus in it, your skin is 'programmed' to keep it from penetrating. Anytime you put anything on your skin that is phospho-lipid deficient, or has no phosphorus~ it penetrates right through."

Emu farming is now a growth industry, particularly overseas where for example:

- emu farming is conducted in more than 17 countries;
- the North American flock alone numbers in excess of one million emus on farm.
- six farms exist in China (the largest contains 25,000 emus & ostriches),
- the largest farm in France has about 8,000 emus; and
- a Chinese company recently purchased a 50% share in a Western Australian deer & emu farm for $1.5M.

Therapeutic Registration

The Therapeutic Goods Administration office (TGA) in Canberra administers the registration of products claiming a therapeutic capability. Therapeutic product labelling, brochures and advertising are policed to ensure manufacturers comply with the Australian Government's legislation. Manufacturer's must justify and have accepted their therapeuticclaims. All registered products can be identified by an "AUSTR number printed on the label.

In Summary

To date the research material available supports the claims made under certain conditions. The yellow compound or associated other compounds in emu oil has important qualities for arthritic pain relief, accepted anti -In flammato ry qualities and the pure oil has skin repair properties, under certain conditions, however, users of products may conclude:

- Manufacturers of Australian registered therapeutic products must Justify, to the TGA, and have their claims accepted.
- Emu oil offers unique proper-ties, some understood, some remain a basis of traditional medicine and others are yet to be fully researched.
- Emu oil is not a sun screen.
- It is important to protect the oil, through handling and packaging, from strong sunlight.

Further research has been funded by the Australian Government's Rural Industries Development Corporation and the emu industry.

NO 4: SUBSTANCES in EMU OIL (By Leigh Hopkins)
June, 1998 update from presentation at the May meeting of the American Oil Chemists' Society (Internet)

Emu oil is composed of triglycerides, the classical neutral fats, which are the primary components in storage fats. These storage fats are the body's most efficient means of storing energy. Due to the presence of the large fat storage pads on the back of the carcass, the emu is unusual in having a disproportionately high ratio of fat to meat in contrast to other members of the ratite family. It is instructive to look for other fat-soluble substance which may be found in the oil but, in general, emu fat should be no different than other animal fats in regard to these other fat-soluble substances. We consume other animal fats in larger quantities through our beef and chicken meals than we would be exposed from our topical use of emu oil. No hormonal or vitamin activity, either good or bad, is attributed to these other animal fats.

Consideration of the presence of substances other than triglycerides and fatty acids in emu oil:

1. Naturally Occurring Substances - Hormones and Vitamins

The naturally occurring fat-soluble vitamins and hormones would be ideal candidates to look for in emu fat since many of the beneficial attributes from the topical use of emu oil are similar to the activities of these hormones and vitamins. Currently, a research project at a major university may afford a broader look at many of these substances than has previously been reported. The AEA Oil Standards Team has completed an analysis of the vitamin D content of the emu oil and found vitamin D activity at a concentration similar to that found in emu blood and human blood. While the emu blood contained the usual active form of vitamin D, we can only assume that the specific vitamin D in the fat was the same form since a different assay methodology was necessary to determine the vitamin D content in the fat.

A less rigorous analysis for hydrocortisone, the primary hormone of the adrenal cortex with anti-inflammatory activity, did not find the presence of this hormone. It should be noted that measuring these fat-soluble substances in fat is technically difficult in comparison to their measurement in blood. Our limited experience to date suggests a working hypothesis that the concentration of the naturally occurring, fat-soluble substances such as the steroidal hormones and the fat-soluble vitamins will be in physiological quantities. That is to say, they will be found in levels consistent with normal physiology and will not be found at elevated or concentrated levels relative to the concentrations found in blood.

There are several different vitamins and hormones that will be evaluated in future studies by researchers at Iowa State University. The analysis of DHEA and its metabolite, DHEAS, in emu fat has been completed and was presented at the May, 1998 meeting of the American Oil Chemists' Society. DHEA is a naturally occurring hormone that has gained recent attention. Like many hormones, there is a decline seen with aging and some have suggested that DHEA be supplemented for an antiaging benefit. Very low levels of this hormone were found in the fat. These levels were considerably lower than were found in the emu or human blood.

2. Fat-soluble substances from other sources - Pesticides

Fat-soluble substances can also be obtained from the environment through the soil and feed and through drugs used to prevent or treat diseases. Determining what quantities of these substances are present requires assay tests are specific for these substances. There are a series of contaminates which can routinely be monitored in meat and oil samples. Most of these are the pesticides that may be obtained from the soil and feeds.

We have evaluated these substances on 5 lots of oil. These 5 lots were 4 lots of emu oil and one of rhea oil. Three of the emu oil lots were finished oil and the other two lots were crude oil. Unfortunately, the Food & Drug Administration has abandoned its effort to establish the tolerance levels for these substances. Modern technology for analysis of these substances enables detection of quantities so small as highly likely to be insignificant. Without the establishment of tolerances to aid in the interpretation of the results, the appearance of any amount of these substances could be viewed as a positive test. Therefore, the routine measurement for any such substance is problematic without tolerances that have an official standing. We believe that our general statement in the oil standards guidelines is a reasonable position to take:

Bird Conditions
"Birds intended for processing into meat and/or oil should be disease-free healthy birds. They should be raised in an environment which guarantees that products derived from the carcass comply with international standards for contamination with antibiotics, pesticides, herbicides, heavy metals, worming medicines, growth stimulants, hormones and/or like substances."

Implications for the presence of various substances in emu oil:
General concerns exist for the impact of substances in the emu oil due to the potential ability of the emu oil to enhance penetration through the skin. For that reason, it is helpful to know if these substances are present in concentrations, which are consistent with normal blood levels (in the case of hormones and vitamins), which we have called physiological concentrations, or if these substances are present in relatively concentrated quantities which might be important if an action from these substances is possible, i.e. a pharmacological concentration. The quantity of a normal substance in the blood, such as hydrocortisone, automatically defines the physiological concentration.

An example may help to explain the difference between physiological vs. pharmacological concentrations where physiological concentration is the concentration in the blood and pharmacologic concentration is that required for an action to be observed upon application or ingestion of the emu oil.

Hydrocortisone is a normal hormone that has an anti-inflammatory action and is available in tablet, cream and injectable formulations. The normal amount of this hormone found in the blood, in the morning hours when it is the highest, is approximately 20 micrograms per 100 ml of blood. If the hydrocortisone in the emu oil were also 20 micrograms per 100 ml of emu oil, we would say that it is a physiological concentration. (To date, we have not been able to identify hydrocortisone in the emu oil.)

The pharmacological dose of hydrocortisone that is required for an effective topical dose, i.e., a pharmacological dose, in the commercial cream is 0.5% or 0.5 grams per 100 ml of cream. This is a very important point since this analogy helps us to understand the amount of hydrocortisone or other substances that must be present before we experience the desired anti-inflammatory action from the cream. The amount of hydrocortisone (0.5%) is equivalent to 500 mg or 500,000 micrograms per 100 grams of cream. So the topical concentration of hydrocortisone necessary to have an anti-inflammatory action is 500,000 micrograms per 100 ml or grams.

Therefore, the physiological concentration of hydrocortisone at 20 micrograms per 100 ml that we may eventually find in the emu oil will have no anti-inflammatory action since we would need to have 500,000 micrograms per 100ml as explained above. While these numbers may sound difficult to believe the first time one reviews this subject, they apply for all the substances found in emu oil. While it is possible that some undesirable substances may someday be found in the emu oil, it is very remote that they possess any threat (i.e., a pharmacological quantity) to the users of the oil since their concentration in the oil will be so low in comparison to the pharmacological concentration that is required for an activity to be seen.

To date we have only determined the concentration of vitamin D and DHEA and DHEAS in the emu oil. These conforms to the analysis just presented with concentrations that are similar to or less than those that are found in the blood of the emu. The vitamin D or DHEA in emu oil should contribute no part of the activity seen from the topical application of emu oil.

NO 5: OIL PRODUCTION TECHNIQUES AND STANDARDS (By J. G. Johns)
Proceedings 1996 World Emu Symposium. ADELAIDE.

Regal Research Laboratories has been involved in researching emu oil and other emu related areas since 1993.

History
Regal Research Laboratories became involved in the development of $C0_2$ extraction processes for specific vegetable and fish oil research commenced in 1984.

Since then we have carried out a great number of research extractions and separations including derivatives extracted from various vegetable and fish oils. Initial extractions of fish oils were obtained from solid fish material, (the meat). In 1985/6 we conducted a comprehensive research program involving the investigation of the presence of Omega-3 fatty acids (EPA DHA), Eicosapentaeroic acid and Docosahexaenoic acid. These are the principal long chain unsaturated fatty acid triglycerides in fish oils. The research was carried out on all species of fish that live in the ocean areas of the Pacific North West.

Further research was carried out to determine the relationship of oil yields and quality of EPA and DHA levels in farm-raised salmon versus wild, and in particular as it applied to types of feed in the case of farm-raised fish.

At the same time we were engaged in a parallel program concerning the extraction and evaluation of vegetable oils from seed high in gamma linoleic acids. It was found the quality of fatty acids was tied to seed quality and seed generic production, in the same way that the quality of Omega-3 oils from Pacific North West salmon of all species were tied, in many cases, to food intake.

Since then we have operated a super critical fluid pilot plant which will be discussed in more detail later in my talk, that enabled us to carry out extraction of derivatives such as squalene from fish oil and the separation of mono and polyunsaturated fatty acids. Some of these derivatives are now successfully used in products manufactured by our manufacturing company, Evolutionary Extractions Inc.

Initial extractions from fat were conducted by supercritical fluid extraction using the raw fat material. During the fish oil research period we developed a proprietary process for the extraction of material from liquids, namely rendered oil. We have since modified and upgraded this proprietary process to allow us to extract, which includes deodorising, high purity products from rendered emu oil. We have, in fact a process which is analogous to steam distillation conducting fractionations by means of varying pressure, instead of temperature, from low to as high as 350 bars.

Production, all methods
We have researched a number of processes to extract oil from emu fat. These include:

1. Autoclave crude rendering with built-in internal first stage filtration and second stage vacuum filtration followed by multi-stage temperature controlled and microbial controlled filtration, suitable for industrial chemicals.
2. Microwave processed using food grade commercial line carriers followed by multi-stage pressure and vacuum filtration final stages temperature and microbial controlled filtration using the molecular sieve Principle. Suitable for some healthcare and veterinary processing.
3. Crude rendering using microwave system followed by supercritical fluid extraction which provided the highest level of purity.
4. Crude rendering and centrifuging. Suitable for industrial chemicals.
5. Supercritical fluid extraction.

Background
Although Haney and Hogarth reported the unusual solvent powers of supercritical fluids over one hundred years ago, supercritical fluids have only recently gained prominence. The long lead time is, in part, attributable to the difficulty in understanding the physical nature in supercritical fluid.

Supercritical Fluid Extraction (SFE), also referred to as dense gas extraction and supercritical gas extraction, is a high pressure solvent extraction process characterised by the use of supercritical fluid in place of conventional liquid solvents.

Although the procedure is rather complicated, and requires sophisticated high pressure equipment, its popularity has grown almost exponentially over the last twenty years.

The gas most used for supercritical extractions is the inert gas carbon dioxide, known as C02. While in the supercritical state the gas resembles both a gas in terms of its viscosity and diffusivity and liquid in terms of its density. Although a variety of substances can be used in their supercritical state for extraction, common gases such as carbon dioxide hold the greatest prominence.

The solvation power of gaseous carbon dioxide is weak. However, as the physical state of carbon dioxide is altered so that it becomes a supercritical fluid, its solvation capacity increases dramatically, and it becomes an effective solvent. This phenomenon, though poorly understood, is believed to occur primarily because of the large change in density that carbon dioxide exhibits near its critical point.

The solvation capacity of the supercritical fluid is strongly dependent on its density which in turn is proportional to the external pressure applied to the fluid. Compounds extracted by high pressure supercritical fluids can thus be recovered from the fluid by a pressure reduction. Additionally, effective separations can be achieved by a variation in temperature rather than pressure. CO_2 in its supercritical state can be an ideal fluid for extraction and separation processes. Although supercritical carbon dioxide has many advantages it is by no means the only useful supercritical fluid.

Many other gases and liquids in their supercritical state can selectively extract components from multicomponent mixtures. This technique offers new opportunities for improvements for existing separation techniques and the development of new processes for difficult product separation.

Compared to conventional separation and extraction techniques, supercritical extraction may be more effective, more efficient and lower in overall costs than alternative processes. And because several supercritical fluids are relatively inert, they leave no solvent residue so that product quality and operational safety are often improved.

How the process works
Supercritical extraction is a unique process that uses the special properties of fluids above their critical temperatures and pressures to separate multi component mixtures. In short, the solvent fluid is pressurised and heated to its supercritical state. Then it is introduced into the extraction vessel at the selected extractor operating conditions. A material being extracted can either be solid or liquid phase.

In the extractor the supercritical solvent selectively extracts one or more components from the source material. The solute supercritical fluid exits the extractor and undergoes a temperature and/or pressure change. This change decreases the solubility of the solute in the solvent fluid and, due to the change in solubility, a solute/solvent separation takes place in the separator vessel. Solute is removed and the solute-lean fluid is pressured and recycled in a continuous flow.

Five basic sub systems
A process development unit pilot plant or full scale commercial plant for supercritical extraction involves the same five basic sub systems:
1. Supercritical fluid supply system.
2. An extraction system.
3. A pressure/temperature control system.
4. A separation system.
5. A recycling system.

The supercritical fluid supply system may be either a pure fluid or a pure fluid with a specific concentration of entrainers (modifiers) that change the characteristics of the separation process by increasing the efficiency of the extraction, or fine tuning the extraction for a particular component of a multicomponent mixture.

In the extraction system, various considerations such as the operating pressure and temperature of the extractors, the compatibility of the material of construction with the process, the closure design, and the cycle life of the pressure vessel are key design parameters.

The temperature or pressure gradient applied across the separator vessel will result in a fractional separation of multicomponent mixtures by varying the pressure and/or temperatures in the vessel.

Solute laden solvent exiting the extractor section undergoes a pressure change between the extractor and the separation system that causes a lowering of the solubility of the solute in the solvent. Therefore, the solute separates from the solvent and is collected in the separation system.

Highly automated
Advance systems designed for supercritical fluid extraction, whether operating for research process development or as a commercial unit, require a high degree of automation for process control and data acquisition. Process control functions or on/off events are directed by a series of microprocessors at the distributed control level. System software incorporates proper failsafe control sequences so that the system can be shut down without damage to itself or to operating personnel. One of the latest developments in our proprietary process is in-line gas chromatography used as part of the separation derivatives loop and is applied depending upon the characteristics of the products being separated.

During the last few years there has been a growing public concern regarding health issues. Many food additives have become suspect and petroleum solvent residues have become far less acceptable. Supercritical fluid extraction on the other hand can utilise safe, low toxicity gases such as carbon dioxide for the extraction of food products.

The supercritical fluid pilot plant that we have operated since then has enabled us to carry out extraction of derivatives such as squalene from fish oil and the separation of mono and polyunsaturated fatty acids. Some of these derivatives are now successfully used in products manufactured by our manufacturing company, Evolutionary Extractions Inc. However, all products do not require SFE emu oil processing, ie. industrial chemicals.

Grading of oil
When we became involved in emu oil research three years ago we found variations in oil quality existed with products rendered from emu fat, both back and intestinal. To deal with this problem effectively we put together a grading system of numbers 1, 2 and 3 grades which would enable the total amounts of fat to be utilised including the poorest grade.

In doing so, we established a development program for products that could be produced utilising high to lower grade oils. The grades were established based on the following market areas:

1. Cosmetic, healthcare and pharmaceuticals.
2. Veterinary.
3. Industrial chemical.

The cosmetic and pharmaceutical areas did not present as great a challenge as the second and third areas as we had been involved with formulations of cosmetic oils, essential perfumery oils and pharmaceutical oils for some time. The number two veterinary area presented some challenges but the results of development appeared to be fruitful and promising. The number three area covering industrial chemicals became a major challenge. What do we do with the third rate poor quality oil? Fortunately, our company research covers a diversified industrial area and we are approached constantly with industries' problems.

Our research clients include the aerospace, marine, horticultural, agricultural, pharmaceutical, cosmetic and electronic/electrical industries. Our knowledge that certain problems exist or have existed in these industries for many years gave us the direction to look at the possible development and application of products which could employ low grade emu oil.

We gained a little help from the U.S. EPA due to the fact that in certain industries some of the products were becoming unacceptable with regard to their being highly toxic, carcinogenic or in general a major health hazard. For us to arrive at a time when the users of these products were frantically looking for replacements was most certainly an act of Providence. What we had to offer was a product consisting of oil from the emu, a flightless bird originating from Australia, and a number of other non-toxic natural product ingredients extracted from seed oils or roots of botanicals. In all cases the magic words were "you can drink it".

The grading of the oils was first based upon peroxide values, as this was the main criterion required for the cosmetic, healthcare and pharmaceutical industries. The peroxide values we have set for categorising oil by our manufacturing company are as follows:

13-2.5	Grade 1
2.6-10	Grade 2
10+	Grade 3

This enabled us to obtain an initial separation of rendered oils. It was followed by a more comprehensive grading requirement based upon a range of classical laboratory analytical tests that would necessarily apply to the types of markets the products would enter.

The grade would be referenced to the product, and also the method of extraction and refining. For example SFE processing would apply to cosmetics, pharmaceutical and some healthcare and veterinary products. Microwave rendering and molecular sieve processing would apply to other health care and vet products.

Other processing, such as microwave rendering followed by centrifuging or vacuum filtration, would be applied for industrial chemical products. The methods of processing would also be tied to the economics of the marketplace.

Standards

The establishment of standards for oil production must be based upon the chemical and physical properties of the oil as rendered from fat. Separated standards will be required for different industries.

In the absence of any standards, we have taken this interim measure for the products we have so far developed. These products include cosmetics, veterinary and industrial chemical.

The standards for cosmetic, healthcare, veterinary and pharmaceutical products should be based upon the following:

Molecular weight	Iodine value
Refractive index	Ester value
Peroxide value	Clarity
Acid value	Colour
Saponification value	Viscosity

Other oils, such as some used in health care and veterinary products, do not require such stringent standards. Oil used in industrial chemicals will require even less stringent standards.

Our manufacturing company is at present holding discussions with its clients with regard to establishing acceptable standards in respect to different industries. We would like to open dialogue with other laboratories and producers, to exchange information on this subject.

Conclusion

Our emu oil research is ongoing, and is based upon the premise that there are other properties not yet found that are responsible for the anti-inflammatory condition. We are at present investigating the control mechanisms that affect the formation and transformation of the polyunsaturated fatty acids.

NO 6: OIL MARKETS AND MARKETING (By J. G. Johns)
Proceedings 1996 World Emu Symposium. ADELAIDE.

Regal Research Laboratories has been involved in researching emu oil and other emu related areas since 1993.

Our early research into the properties of emu oil provided us with a number of possible uses of the oil in addition to cosmetics and pharmaceuticals.

These additional uses included areas of veterinary application and industrial chemicals for a variety of industries.

Some areas of today's discussion may seem far from the conventional uses of emu oil, but they could provide producers with a more diversified market.

During our investigations we found that there were varying qualities of fat which produced different qualities of oil. For example, what does one do with the oil that does not meet the requirements for cosmetic or pharmaceutical applications? Throw it away?

A solution to this problem was to grade the oil into three categories based upon the standard requirements of applicable industries.

The basis of these standards was discussed in my talk on oil production and standards delivered yesterday at the conference.

From the marketing standpoint the industries targeted would be the cosmetic, pharmaceutical, veterinarian and industrial chemicals in order of oil quality.

Cosmetics
In the area of cosmetics the penetrating action and moisturising properties of the oil are becoming better known. This, therefore, lends itself to a number of interesting cosmetic products, namely skin creams and lotions, skin moisturisers and as a sunburn treatment for heat damaged skin.

Due to its compounding properties it can be used as an emulsifier with other oils. Studies are now progressing regarding the use of emu oil as a carrier constituent with other blended oils for vitamin penetration. Test trials conducted in Canada have found that pure oil or oil included in a cream, is an excellent moisturiser for dry skin and cracked lips. This problem is very common in our cold winters, with high wind chill factors.

The oil should be considered an excellent product for use as a massage in massaging establishments. It does not create the heat rise due to friction on the skin, but rather a silky effect which allows masseurs to perform their art for much longer periods than would be possible with existing massaging oils or creams.

Studies are continuing regarding its use as an anti-wrinkle cream, due to its ability to soften lines and wrinkles. This in itself could present an extremely large market.

Pharmaceutical and Healthcare, Therapeutic Products
This constitutes one of the potentially largest markets for emu oil.

We are dealing with an ageing population. Consequent to that is the increasing problem and cost of healthcare as it relates in particular to inflammatory and associated arthritic conditions causing pain in joints, namely - knees, feet, fingers and elbows.

The early use of the oil by the indigenous people of Australia as a treatment for muscular and joint problems has been well documented. From a number of studies conducted the consensus seems to be ',that it works".

However, consideration must be given to how it is produced and how it is applied.

In some cases the oil applied as a massage can be effective, in others, a cream with more viscosity of a paste, to be applied as a compress should be offered.

The cost effectiveness of the treatment versus other established drugs and treatments should be reviewed and dialogue established with the medical health authorities as to the inherent cost savings of emu oil treatments.

Other healthcare markets include treatments for:

Burns
A number of studies have been conducted on bum victims. Both emu oil and/or creams have been applied soon after an accident involving, in some cases third degree bums. Pain was greatly reduced and healing was much faster with less scarring.

Again, the methods of production and application are important. During early blistering, pastes, creams and gels may be painful and difficult to apply. A spray application should be considered with cream applied later.

Bruising, Sprains and Muscle Pain due to falls
This is a problem often encountered with the elderly.

Emu oil or cream applied and massaged into the skin in the affected areas a number of times per day can provide faster relief from pain than the commonly prescribed embrocations.

Again, the healthcare cost, whether it is born by the state or the individual, becomes a factor. The price of the emu oil or cream versus pain killers and other prescribed drugs and embrocations is also a factor.

Sports and Athletic related Muscle Problems
Sports such as rugby, football, hockey, etc. promote some dangerous or superficial injuries involving sprains, pulled tendons, bruising and general muscular pain. A large market exists in this area.

Massaged oils or creams are ideal for the problems encountered in these very aggressive sports.

Pharmaceuticals
At this stage of emu production and market development I would not recommend entering this very expensive field as a producer of pharmaceutical products.

A better way would be to become a supplier of either high quality, high purity oil or some derivatives of it to a pharmaceutical company. But be forewarned, this route can also be very expensive, time consuming, and one must be prepared to wait for some considerable time for any returns, even though they could be well worthwhile in the end.

There are derivatives that can be fractionated and separated using methods described in my talk yesterday, but they require very sophisticated equipment which is also very expensive.

Veterinary
Some areas of veterinary medicine concern the same problems as humans, namely muscle aches, sprains, tendons, etc. The oil rubbed into affected areas can prove to be beneficial and relieve pain.

The twin benefits of reducing both healing time and the effects of scarring are applicable, for example, to horses suffering from cuts due to barbed wire, sharp metal protrusions and other general hazards, as well as to many other animals requiring veterinary attention.

Emu oil has been used successfully in trials as a treatment of these injuries with a noticeable reduction of scarring. The same applies to dogs as a result of accidents, involving surgery or abrasions.

Industrial Chemicals

Aerospace applications:
Potential applications exist in the polishing and grinding of aluminium die castings, sand castings and wrought shapes. Aluminium by its weight, strength and machinability is used in large quantities in the aircraft industry.

We have found that emu oil can be used as a constituent in compounds used as lubricators for the polishing of aluminium. The lubricant prevents gouging and excessive frictional heat rise when fine polished surfaces are required.

Other formulated compounds using the oil can beneficially affect the life, rate of cut and finish produced, while eliminating damage due to heat sensitive materials such as plastics and glass by minimising heat build up.

Automated machine parts:
Further uses of emu oil as a constituent in polishing pastes, cutting oils and cutting fluid coolants have been formulated for processing cold rolled steel, stainless steel, copper and copper alloys and titanium.

Electronics and electrical power industries:
A kilowatt-hour of electricity can light a 100 watt lamp for 10 hours, or lift a ton 1,000 ft. in the air, smelt enough aluminium for a six pack of beer cans, or heat enough water for a few minutes shower.

To save money and ease environmental pressures, can more mechanical work or light, more aluminium or a longer shower be wrung from that same kilowatt-hour? The answer is Yes.

The biggest savings in electricity can be attained in a few areas, lights, motor systems, and refrigeration of food and rooms.

In the area of lighting up to 55% can be saved through cost-effective means. Thus lighting innovations may be one of the largest markets generated by the electrical industry today.

What has this to do with emu oil? The electronics industry is developing electronic drivers capable of supplying appropriate power to FED (High Intensity Discharge) lamps. However, the high operating temperatures of HID lamps pose a stringent problem to the driver designer. By nature, the lifetime of any electronic component decreases as the operating temperature rises.

NO 7: RESULTS of OIL RESEARCH (By Michael Whitehouse)
Australian Emu - March/April 1997

Late last year I started testing some oil samples that had been supplied by PeterThompson (QLD), John Snowden (WA) and Greg Barowski (Vic) to assist us with research into the differences in arthritis treatment in emu oil. In the last 12 months we have tested about 40 samples and have obtained some interesting results.

This research has primarily involved emus sourced in Queensland and with much encouragement from Peter Thompson and John and Fay Spencer. It would also not have been possible without assistance from Craig Davis of the Queensland Department of Primary Indus-tries, Desley Butters and AtholTurner Whilst this work would not have been possible without their help, there is no way that the challenges confronting the research needs of emu oil will be satisfied if we continue to rely on this level of funding and assistance.

I therefore applaud these people for agreeing to let me indicate the results from what I have been doing. Following therefore is an overview of what we have been trying to do and a summary of results to date. It is too early to draw any conclusions other than to state that there is a very large variation in the anti-inflammatory potency of the emu oil samples that I have tested to date. My colleagues in this Hospital, Dr Sherree Cross, and Dr Snowden will be looking at the healing potential of some of these oils to see how this correlates with the anti-inflammatory activity

Further research is needed and I am extremely pleased to know that PeterThompson will be setting up several pens for different nutritional regimes so that we can follow these through in a few months time to see what, if any, variation we find in the medicinal potential of the oils.

The major objective of the research has been to find a source of oil with a consistent high level of biological activity that we can use as a benchmark for further testing and for the development of a chemical test that does not require the use of rats. Dependence on rats for testing for beneficial medicinal properties is not only expensive and time consuming but is likely to be limited due to the pressures associated with animal rights pressure groups.

Having the opportunity to test samples where we know the whole history of the birds that the fat has been suppled from, has been an essential prerequisite for these trials. Also the knowledge that we will be able to source additional birds from the same supplier when we locate the ideal outcome has been equally as important.

Results of this research have revealed a large variation between different samples. Based on our scoring system which provides an overall anti-arthritis score of from 1 to 100, we have obtained results ranging from 0 to 8 1.

Whilst it is too early to draw conclusions as to what conditions or prerequisites provide the best oil in terms of biological activity (particularly potential for treating arthritis) we have been rather dismayed by the large variation in samples.

The samples tested have included differences based on “Oils ain't Oils".

NO 8: ANTI-INFLAMMATORY ACTIVITY OF EMU OILS IN RATS (By Snowden, J. M and Whitehouse, M.W)
Journal of Inflammopharmacology. (1997);5:127-132.

ABSTRACT

The anti-inflammatory activities of five different preparations of emu (Dromes Novae-Hollander) oil, applied topically, have been examined using an experimental polyarthritis in rats. Four of the preparations were found to be active against adjuvant-induced arthritis in rats, The efficacies of the emu oils acting transdermally are compared with that of orally administered ibuprofen (40 mg/kg).

INTRODUCTION

To date the evidence for the transnormal efficacy of emu (Dromes Novae-Hollander) oil as an anti-inflammatory agent has been largely anecdotal, such as the use by Australian aboriginals for centuries to treat inflamed joints. The first accounts of the efficacy of this oil were published in the mid-1800.s [1]. However, recently, a wide range of therapeutic applications for the oil have been claimed in two United States patents 12,,11, Unfortunately, no statistical evaluation of the results was presented in these patents.

Also, it is often stated that emu oils from different sources and refined by differing processes differ widely in their therapeutic activity but no scientific -studies have been published that confirm this.

In this preliminary study, the anti-inflammatory activities of five different preparations, of emu oil have been examined using an experimental polyarthritis in rats that has been commonly), used for the detection and development of clinically effective anti-inflammatory drugs [4-6]. The oils came from birds raised in quite different habitats, three of these from Western Australia and two from Queensland.

MATERIALS AND METHODS

Emu Oil Samples

Emu oil 1 (E01) is a commercially available preparation from Western Australia, It is a bright yellow clear liquid without significant solids at room temperature, It was kept in a brown bottle in a cold room until required, This oil is believed to contain an added anti-oxidant. Emu oil 2 (E02) was prepared from the fat of birds raised by Agriculture Western Australia and contained approximately 65% subcutaneous fat and 35% intra-abdominal fat. The fat was rendered in a commercial rendering plant and the crude oil contained a considerable quantity of solid material at room temperature. No anti-oxidants were added. The crude oil was stored at room temperature in sealed white plastic containers and was exposed to limited natural light. The crude oil was stored for approximately 2 months before being used. Prior to testing, the crude oil was filtered through cotton wool. The oil as tested was a very pale clear liquid with very little solid material. Emu oil 3 (E03) was prepared from the intra-abdominal fat of birds raised by Western Australia. Approximately 1 kg of fat was heated in a 650-W microwave oven on high for about 20 min. The oil was then filtered through cotton wool and stored in a glass beaker sealed with plastic wrap. The oil was stored in a cupboard, to reduce its exposure to light, at room temperature before being tested. No anti-oxidants were added to the oil. The oil used was almost colourless with approximately 10% solids at room temperature. Emu oil 4 (E04) was prepared by Dr C. Davis, Department of Primary Industries, Hamilton, Queensland. The oil was prepared from the subcutaneous fat of an emu raised at Cherbourg, Queensland and finished for 6 weeks at the Department of Primary Industries facility at Gatton, Queensland. The oil was obtained by low-temperature (40^0C) rendering and clarified by centrifugation at 12 000g for 10 min at 30^0C. As tested, the oil was almost colourless with a small quantity of solids at room temperature. Ernu oil 5 (E05) was a commercially rendered preparation prepared from the fat of birds raised at Cherbourg, Queensland. As supplied the oil contained approximately 25% (v/v) solids. The crude oil was filtered before use. The oil used was a pale yellow viscous liquid.

Animal Testing

For the main study, adjuvant arthritis was induced by injecting a mixture of *M. tuberculosis* (800 µg) in squalane (0.1 Mlle) into the tail base of female Wistar rats (160 200 g) on day 0. On day 10, the rats were shaved just behind the ears to expose approximately 6 cm^2 of dorsal skin. Mixtures of 85% (v/v) emu oil and 15% cineole, a penetration enhancer [7], were prepared. A mixture of 85% olive oil and 15% cineole was used as a negative control. The mixtures were applied at the rate of 2 ml/kg on days 10, 11, 12 and 13. Eight rats each were treated

with E0s 1, 2, 3 and 4. Six rats were used as controls. The rear paw diameters were measured on days 10 and 14 using a micrometer.

Also, on day 14, the severity of the arthritis in the front paws was scored by two independent assessors, using a range of 0 (no arthritis) to 4 (severe arthritis). To examine the dose-response, mixtures of L05 and olive oil in the ratios of 1:1 (E0.00 1:1) and 1:3 (E0:00 13) were prepared. Adjuvant arthritis was induced in a further 16 female rats and oil day 10 the rats, were shaved and the rear paw diameters measured as described above. Mixtures of 85% E05, EO:00 1:1 or E0:OO 1:3 and 15% cineole were prepared and each applied to four rats (2 ml/kg) on days 10, 11, 12 and 13. Again a mixture of 85% olive oil and 15% cineole was used as a negative control on four rats. The rear diameters were measured again on day 14.

In a subsequent study, adjuvant arthritis was induced as described above in a further sixteen female rats. On days 3 0, 11, 12 and 13, eight of the rats were given doses of 40 mg/kg ibuprofen po, The remaining eight rats were given no treatment. The rear paws were measured oil days 10 an(] 14. The severity of the arthritis in tile front paws was assessed on day 14.

Statistical analysis

In the tables, results are expressed as the mean and standard error of the mean. Statistical analysis was by ANOVA followed by Student's t-test when significant differences were obtained. A one-tailed t-test was used for comparing: the emu oil preparations with the control arid a two-tailed test was used when comparing emu oil preparations, Results were considered significant when p was < 0,05,). In all cases the difference in mean paw diameters is the mean diameter of the paws on day 14 minus the mean diameter of the paws on day 10 in mm. The significance levels quoted in the tables are the comparison of the treatment. with the control,

RESULTS

Paw diameter measurements

In all Studies there were no significant differences between the size of the paws of each group of rats prior, to the commencement of treatment (day 10).

Also, in all studies, there was no significant difference in the change in paw diameter between left and right paws and so the means of the 14 and right paws of the one animal were compared.

ANOVA of the mean paw measurements obtained in the oil study gave a p value of' <0,001. It can be seen (Table 1) that dermal application of three of the four ernu oil preparations significantly reduced the increase in paw diameter due to arthritic inflammation over the treatment period. Also, E04 was significantly more effective at reducing swelling than E02 or E03, the negative value showing that it reduced incipient inflammation already pre-established on day 10.

The actual mean (±SEM) diameters on days 10 and 14 respectively were 7.06 (±0.05) and 7.74 (±0.05) mm for the control group, 7.06 (±0.05) and 8.11 (±0.50) mm for the E01-treated group, 7.10 (±0.02) and 7.38 (±0.07) mm for the E02 treated group, 7.11 (±0.01)and 7.32(±0,27)mm for the E03-treated group and 7.21 (±0.02) and 6.92 (±0.007) mm for the E04-treated group.

The results from scoring the severity of the induced arthritis in the front paws are in agreement with the results of the rear paw measurements (Table 2).

TABLE 1: The effects of various emu oil preparations on the swelling of rear, paws induced by caudal injection of M. tuberculosis in squalane.

	Control (n = 6)	E01 (n = 8)	E02 (n = 8)	E03 (n = 8)	F04 (n = 8)
Mean (mm)	0.72	1.00	0.25	0.19	-0.27
SEM	0.06	0.25	0.11	0.20	0.15
Significance (p)		NS	<0.001	<0.01	<0.001

NS, not significant

TABLE 2: The severity of the adjuvant-induced arthritis in the front paws.

	Control (n = 6)	E01 (n = 8)	E02 (n = 8)	E03 (n = 8)	F04 (n = 8)
Mean (mm)	2.27	2.46	1.19	1.29	0.63
SEM	0.33	0.32	0.23	0.22	0.16
Significance(p)		NS	<0.01	<0.01	<0.001

NS, not significant

None of the rats showed any adverse skin reactions at the site of application of any of the oil preparations, All groups showed a slight weight gain (3-8 g) over the treatment period but there was no significant correlation between weight gain and efficacy.

A significant effect of diluting E05 with olive oil was observed (Table 3). EO5 and EO:OO 1:1 were significantly more effective (p<0.05) than EO:00 1.3.

Cineole, applied dermally in olive oil or lard oil, showed no anti-inflammatory activity in parallel experiments.

The administration of ibuprofen (40 mg/kg) significantly reduced (p<0.001) the increase in paw diameter due to arthritic inflammation over the treatment period. The mean values for control and treated groups were 1.41 (± 0.09) and 0.67 (± 0.11) mm, respectively. Ibuprofen did not, however, significantly reduce the arthritic score for the front paws. The mean scores wore 2.44 for the control group and. 2.35 for the treated group.

TABLE 3: The effects of diluting emu oil with olive oil on the swelling of rear paws induced by caudalinjection of *M. tuberculosis* in squalane.

	Control (n = 4)	E05 (n = 4)	E0:001:1 (n = 4)	F04 (n = 4)
Mean (mm)	1.41	0.17	0.24	0.49
SEM	0.46	0.02	0.07	0.05
Significance (p)		<0.05	<0.05	NS

NS, not significant

DISCUSSION

This study provides firm evidence that some topically applied preparations of emu oil may be efficacious in the treatment of at least some forms of inflammation. To ensure this activity is manifested after dermal application, however, it may be necessary to add a skin penetration enhancer [7]. We have used cineole, the principal terpene constituent of eucalyptus oil. In terms of reducing the paw swelling, the topical application of E0s 2 and 3 would appear to have effects, comparable to the oral administration of ibuprofen (40 mg/kg), a readily available over-the-counter anti-inflammatory drug.

The results also, demonstrate that, as often discussed but rarely demonstrated, not all preparations of emu oil exhibit the same activity. The reason(s) why the preparations vary so widely in their anti-inflammatory activity is still unknown and illustrates the requirement for further work.

ACKNOWLEDGEMENT

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REFERENCES

1. Bennett G. Observations Principally on the Animal and Vegetable Products of New South Wales; Gatherings of a Naturalist in Australasia, London: John Van Voorst, Paternoster Row; 1860.
2. Ghosh P, Whitehouse M, Dawson M, Turner A. Anti-inflammatory composition derived from ernu oil. United States patent number 5,431,924. 1995.
3. Fein E, Caputo J, Nagal K. Therapeutic uses of emu oil. (United States patent number 5,472,713. 1995.
4. Whitehouse MW. Adjuvant induced polyarthritis in rats. In: Greenwald RA, Diamond IIS, eds. Handbook of Models for Rheumatic Diseases. Vol. 1. Boca Raton; CRC Press; 1988:3-16.

5. Rainsford KD. Adjuvant polyarthritis in rats: is this a satisfactory model for screening anti-arthritic drugs? Agents Actions. 1982;12:452-5.
6. Billingham MEJ. Models for arthritis and the search for anti-arthritic drugs. Pharmac Ther. 1983;21:389-417.
7. Fashida M, Yamashita F. Terpenes as penetration enhancers. In: Smith EW, Maibach MI, eds. Percutaneous Penetration Enhancers. Boca Raton: CRC Press; 1995:309-21.

NO 9: RIRDC Research DAW-82A Milestone 1 (By Dr John Snowden)
EPAV NEWS – Nov/Dec 1997

Project title: Determination of the anti inflammatory properties of emu oil.

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Objects of the project

1. By using an appropriate animal model(s), to determine if emu oil alone or in combination with other agents is efficacious in the treatment of inflammation.
2. Isolate the active agents in emu oil or develop a test to determine the level of efficacy of emu oil.
3. Conduct clinical studies on the efficacy of emu oil.
4. To investigate the effects of the following factors on the efficacy, yeild and properties (physical and chemical) of emu oil.
   1.1 fat handling and storage procedures
   1.2 fat rendering and refining regimes
   1.3 oil storage procedures.
   2.0 To prepare specifications for the production of emu oil to be used in anti inflammatory applications.

Agreed milestoneffl reporting date performance indicators:

Milestone		Reporting date	Performance indicator
1.	Demonstrate the efficacy of emu oil with the carrageenan model.	31.03.97	Progress report to RIRDC
2.	Determine the effects of sex and diet on the eficacy of emu oil	30.09.97	Progress report to RIRDC
3.	Evaluation of rendering regimes and further refining	30.03.98	Progress report to RIRDC
4.	Storage trials	31.07.98	Progress report to RiRDC
5.	Final report	31.03.99	Final report to RIRDC

Progress against agreed milestone(s).

In the past few years emu production has became a multi-million dollar industry in this country. The profitability of this new industry has relied largely on breeding and selling chicks into an expanding industry. However, it is apparent that in the near future- the industry will have to depend on the sale of emu products. The products include meat, skins, fat (oil) and feathers. Based on the current and predicted prices for emu products (meat, skins & oil), it would seem likely that emu farming will only remain profitable if the very high price currently paid for the fat is maintained. Until recently, the price obtained for emu fat is between $20 and $25 per kilo, compared to around 20 cents per kilo for fat from other animal sources, but this will drop rapidly, as increasing supplies become available, unless high value end users are established.

High prices are paid for emu oils because emu oil is believed to have therapeutic and cosmetic applications. To date the evidence for transdermal efficacy of emu oil as an anti- inflammatory agent has been largely anecdotal, such as the use by Australian aboriginals for centuries to treat inflamed joints The first accounts of the efficacy of this oil were published in the mid 1980's.

Also, it is often stated that emu oils from different sources and refined by differing processes differ widely in their therapeutic activity but no scientific studies have been published that confirm this.

In this study, the anti- inflammatory activities of preparations of emu oil has been examined using two experimental rat models that have been commonly used for the detection and development of clinically effective anti -i nflam matory drugs. The first is referred to as the adjuvant induced polyarthritis model. With this model, small quantity of a bacterial cell wall preparation is injected into the base of the tail of the rats. The rats are then left for 10 days for the poly arthritis to develop, which includes the swelling of all paws. The diameters of the rear paws were measured and the oil preparations applied to a shaved area on the back of the rats. The oil preparations were also applied on days 11, 12 and 13. The rear paw diameters were again measured on day 14. The degree of swelling is taken as measure of the severity of the disease.

In the initial study, the anti- inflammatory properties of four different preparations of emu oil were examined. These were sourced from birds raised in quite different habitat, three of these were from Western Australia (E01, E02 and E03) and one was from Queensland (E04). Olive oil was used as the control.

The dermal application of three of the four emu oil preparations significantly reduced the increase in paw diameter due to arthritic inflammation over the treatment period. Also, E04 was significantly more effective at reducing swelling than E02 or E03, the negative value showing that it that it reduced incipient inflammation already pre-estabiished on day 10. Anova of the mean paw measurement obtained in the oil study gave a P of <O. 00 1

The administration of ibuprofen, one of the most effective anti- inflammatory drugs available over the counter, significantly reduced (p<o.ool) the increase in paw diameter due to arthritic inflammation over the treatment period but on average it was less effective than E03 or E04.

The four oil samples where then subjected to a variety of analytical procedures, including nuclear magnetic resonance (NMR) spectroscopy. Simplistically, the NIVIR spectroscopy can be considered to give a fingerprint of the type of carbon and hydrogen atoms in the material. A unexpected finding was the apparent simplicity of all the spectra. This indicates a relative simple mixture of a limited number of compounds. Also, there were no significant differences between the four spectra which indicates that the active ingredient is only a (very) minor component of the oil. Using this and other data, the major component (around 70%) of all the emu oil samples was identified as the triglyceride.

This type of triglyceride is unusual to be present in animal and may at least in part, be responsible for the unusual qualities of emu oil in that there is a unsaturated fatty acid (oleic acid) each end and a saturated fatty acid (palmitic acid) in the middle.

The second animal model used is referred to as the carrageenan induced rat paw oedema model**.** Whilst progress with using the carrageenan induced rat paw oedema model to demonstrate efficacy has been slower than the adjuvant model, the model is becoming better understood and it is now possible to distinguish between the two effects of carrageenan ie. the rapidly induced oedema (0 to 6 hours) and the development of granuloma……

NO 10: EMU OIL(S): A SOURCE OF NON-TOXIC TRANSDERMAL ANTI-INFLAMMATORY AGENTS IN ABORIGINAL MEDICINE (By Whitehouse, M.W, Turner, A.G, Davis, C.K, & Roberts M.S)
Journal of Inflammopharmacology. (199?)

SUMMARY

The 'oil' obtained from emu fat can be a very effective inhibitor of chronic inflammation in rats when applied dermally (with a skin penetration enhancer). Assays for this activity using the adjuvant-induced arthritis model have shown:
(i) considerable variability in potency of some commercial oil samples;
(ii) little or no correlation of activity with colour or linolenic acid (18:3) content of the oil;
(iii) relative stability of some active oils (to heat, ageing at room temperature);
(iv) the bulk of the anti-inflammatory activity was present in a low triglyceride fraction; and
(v) potential arthritis-suppressant/irnmunoregulant activity of these active fractions.

These studies point to the need for more rigid quality control beforeconsidering such a (now proven) traditional medicine as a complementary therapy.Repeated applications of selected oils did not induce any of the more prominent side effects associated with NSAIDs (e.g. platelet inhibition, gastrotoxicity) or certain anti-arthritic drugs (proteinuria, leukopenia).

Introduction
The emu ('bush chook), Dromaitis (novae-hollandiae) is a free-roving, large, flightless bird indigenous to Australia, now farmed in Australia, Canada, Europe and the USA. The native Aboriginals and early white settlers in Australia rubbed on the liquid fat to facilitate wound healing and to alleviate pain and disability from various musculoskeletal disorders.

An adult bird (15 months old) weighing 45 kg carries up to 10 kg of body fat, from which 7-8 litres of a thick oil is obtained by rendering at temperatures up to 1500C. Filtering this semi-solid fat at 25`C yields 20-80% (v/v) of a clear oil (C0); the proportion varying with conditions of nurture and other factors (genetic stock, stress, etc).

These C0s can vary greatly in their content of a) natural antioxidants (e.g. carotenoids, flavones), and b) skin permeation-enhancing (PE) factors (e.g. unesterified oleic acid, plant-derived sesquiterpenes). The content of a-linolenic acid (18: 3) in the total triglyceride fraction varies notably from almost zero (many farmed birds) up to 20% (some feral birds), also reflecting significant influences of the basal* diet on oil composition.

Evidence for the variability in anti-inflammatory potency of different emu oils was first obtained using the rat adjuvant arthritis model (1). This report extends and amplifies previous observations that not all emu oils show similar therapeutic activity when applied dermally. To eliminate variations in the endogenous PE content between clarified oils, 15% (vlv) cineole (eucalyptol) was routinely added to all samples before testing.

EXPERIMENTAL

Unless indicated otherwise, emu fat samples were mixtures of both internal and external fat. These fat samples, free of blood and extraneous matter, were freshly minced at the time of slaughter, packed on ice (if not rendered immediately) and then rendered at controlled temperatures ranging from 30T to 95T. The semi-liquid fat/oil thus obtained showed considerable variations in clarity, viscosity and colour (yellow). For routine testing, these oils and commercial samples were filtered at 251C to remove solids and then diluted with sterile cold-pressed olive oil if necessary (e.g. for dose-response studies).

After admixture with 15% (v/v) cineole (eucalyptol), samples were applied dermally (2.5 ml/kg/day) for at least 4 days to the shaved dorsum (6 cm) of female outbred Wistar rats (160-200 gm) developing adjuvant-induced polyarthritis as previously described (1,2). This protocol measures a therapeutic action, the animals having a pre-established disease, with the first dose being given at the time of onset of arthritis. Signs of arthritis were measured before dosing (day-10 post-adjuvant), after dosing (day-14) and again after a rebound/washout period (day-17). The latter observation served to eliminate those rats which were non-responders (n<- 15%) to the inoculated arthritigen given on day-0.

A blinded independent observer assessed the overall arthritic severity on day 14, giving each animal a score (0 to 5+) based on paw and tail inflammation and general condition of the animal. Changes in rear paw and maximal tail

thickness were measured with a micrometer and forepaw inflammation was assessed arbitrarily (on a scale of 0 to 4+). Data are presented as means from five or more rats per experimental group.

A second assay was based on treating female Dark Agouti (DA) rats (150-180 gm) with test fractions/oils co-administered in the arthritigenic adjuvant, i.e. treatment was prophylactic with a single dose at the time of triggering the arthritis. Wistar rats came from the University of Queensland Animal Farm; DA from the Animal Resources Centre at Murdoch University (W.A.).

Oils proved active in the above assays were further treated by various fractionation procedures, not detailed here, to obtain a) low-triglyceride (active) concentrates which were:56% original oil volume and b) triglyceride-rich oil residues (~:94% (v/v)).

RESULTS

Anti-inflammatory activity of various oils

Tables 1 and 2 expand on data previously presented (1) showing that emu oils can differ greatly in their ability to suppress the expression of an ongoing experimental arthritis in rats when given transdermally in a therapeutic regime. Table 1 compares the activity of several oil samples carrying claims for potential therapeutic activity, assessed as soon as possible after they were purchased from commercial outlets. Some of these oils might have been subjected to vigorous processing (e.g. bleaching) to attain cosmetic grade. Since these data were generated in several experiments over a 24 month period, it is not feasible to record here full details of all measurements on the untreated controls. Likewise, table 2 gives the relative activities of some freshly prepared oils derived from the internal/intestinal fat and the external/rump fat of the same bird; these being feral (i.e. sourced from the wild), farmed intensively and dependent wholly on feed rations, or farmed with free access to considerable natural fodder. Although no simple correlation was evident between oil activity and food supply, the intestinal fat seemed to carry more activity than the rump fat in each instance.

Table 3 shows that the therapeutic activity was reasonably thermostable in some preliminary experiments of heating selected oils. These were first obtained by rendering at 30'C before being divided into two lots for comparison; one lot was then heated to 85` for 3 hours and the other maintained at 25`.

In other experiments not detailed here, it was found that the colour of the oil (very marked in some, but not all, feral emu fat samples) did not correlate with its antiinflammatory activity, as disclosed in this bioassay. Some coloured oils showed marked deterioration in potency on being exposed to sunlight, suggesting that the yellow pigment(s) might have photosensitising activity and may accelerate the deterioration of the active principles.

Table 4 compares an emu oil with other oils believed to have therapeutic value for inflammatory disorders, when applied dermally with 15% cineole. These results indicate that emu fat is a relatively unique source for transdermal anti-inflammatory activity. Oils rich in alpha- or gamma-linolenates e.g. flax/linseed, evening primrose, showed some modest activity. By contrast, no correlation was found between linolenate content of emu ofis (ranging from 0.2 to 19.7%) and overall antiinflammatory activity (data not shown).

Table 5 shows that it is possible to segregate the bulk of the anti-inflanunatory activity into low volume fractions. The oils used in this experiment were from birds fanned by Aborigines at two widely separated locations (2500 km, apart), bred from wild emus captured in their respective neighbourhoods.

Table 6 shows that by either a) co-injecting the active fraction with an arthritigenic olive oil-based adjuvant or b) injecting an alternate adjuvants constructed with test oils (in lieu of olive oil), it was possible to see quite marked difFerences in the severity of the ensuing arthritis. This suggests the active oils contain a component that down-regulates the initial response to the Mycobacterial arthritigen by the inununoreactive cells in the draining lymph nodes.

Preliminary Observations Regarding Safety

Arthritic animals treated with 'good'/active oils consistently gained weight, far in excess of that shown by controls treated dermally with olive oil/cineole (85:15 (v/v)) n-fixtures. At autopsy after 10 dermal applications (2.5 ml/kg/day), no macroscopic abnormalities were noted in post-mortem examinations (n--30 rats). Platelet aggregation, in response to ADP or arachidonic acid ex vivo, was normal. Large doses of a 'good oil' (1 mi/rat) administered orally caused no gastric irritation. By contrast, doses as low as 150 mg/kg of these good oils (suspended in 0.04% Tween-20) actually reduced the gastric irritation and bleeding caused by 50 mg/kg Ibuprofen and 25 mg/kg Naproxen p.o. in disease-stressed rats. We found no evidence for increased proteinuria (beyond that seen in approximately 30% of the untreated arthritic animals) after 10 days treatment with an active oil.

The areas of skin exposed to emu oil (with or without admixed cineole) showed very little/no irritation, in contrast to that seen after applying some other transdermally active drugs, notably certain 'topical' NSAIDs e.g. piroxicam, copper salicylate, etc.

DISCUSSION

This progress report further confirms the likely validity of repeated claims and testimony available in writing since 1820, that Aboriginal lore has located a natural medicine, transdermally active, for easing inflammatory signs and symptoms of musculoskeletal disorders. This testimony, both historic and contemporary, also indicates a likely analgesic action: the data presented here neither affirm or deny this analgesic property.

Quite remarkably, from certain 'good'/active oils it was possible to obtain crude fractions with an activity superior to that of naproxen (w/w). These fractions stifi contain some residual triglycerides and other diluents of the active component(s). These active fractions largely suppressed arthritis development when co-defivered, as a single prophylactic dose along with an arthrithogenic adjuvant, into the lymphatic system. This is a property shared with some anti-arthritic drugs e.g. cyclosporin A (3,4) or zinc monoglycerolate (2) and a few rather unconventional NSAIDs e.g. lobenzarit (4), tenidap and nimesulide.

Like many alternative medicines, the credibility of emu oil has suffiered from overstated claims for poorly characterised products that may sometimes even be adulterated (e.g. with chicken fat or linseed oil) without recognition of this fact. It is of prime importance to assert continuous quality control throughout the whole supply line i.e. from selecting the best birds for (good/active) oil production, their feed and nurture through to the rendering of the crude fat and subsequent preservation of the extracted oil.

This is yet another example of the Conditional Pharmacology, often overlooked when we take for granted the consistency and potency of synthetic drugs. It should be recognised and more carefully defined in the context of using natural-sourced remedies.

One great advantage of emu oils is that they require little refining, unlike plant-derived oils, and present a low health hazard, being readily metabolised like most animal fats. They also come from a renewable and eco-sustainable resource, in contrast to so many petroleum-derived pharmaceuticals.

Acknowledgements

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References

1. Snowden JM, Whitehouse MW. Anti-inflammatory action of emu oil. Inflammopharmcology 1997;in press.
2. Whitehouse NW, Rainsford KD, Taylor RM, Vemon-Roberts B. Zinc monoglycerolate: a slow-release source of zinc with anti-arthritic activity in rats. Agents and Actions 1990;31:47-58.
3. Rofe AM, Whitehouse MW, Bourgeois CS, Haynes DR, Vemon-Roberts B. Prevention of adjuvant-induced cachexia in rats by cyclosporine-A. Immunol.& Cell Biol. 1990;68:63-69.

4. Haynes DP, Gadd SJ, Whitehouse MW, Mayrhofer G, Vemon-Roberts B. Complete prevention of the clinical expression of adjuvant-induced arthritis in rats by cyclosporine-A and lobenzarit. Inflammation Res. 1996;45:159-165.

TABLE 1: VARIATIONS IN POTENCY BETWEEN SOME COMMERCIAL EMU OILS

Emu oils were applied at 2 nil/kg (plus/minus Olive Oil) with 15% (v/v) Cineole for 4 days only (controls received no treatment).

Percent Reduction (on dU 14) o

Source	Dose	Rear	Front	Arthritis Score
Country (Brand)	ml/kg	Paw Swelling		
USA (Triad)	2	47%	0%	28%
UK (Pioneer)	2	40	0	39
Aust/WA (Emu Vertica)	2	77	100	70
Aust/Q1d (Outback)	2	69	37	39
Aust/Vic (Emu Spirit)	1	84	95	65
Aust/WA (Mt Romance)	1	32	23	0.

Only reduction ~:32%, considered significant (N=4/gp)
Tables 3 and 5 (1 st line of data) indicate typical arthritis signs of untreated controls (0% reduction).

TABLE 2: VARIATIONS IN THE POTENCY OF SOME FRESHLY DERIVED UNPROCESSED EMU OILS

Emu oil was applied at 1 ml/kg (plus 1 ml/kg Olive Oil) with 15% (v/v) Cineole for 4 days only. Controls received no treatment.

Bird/Fat Source	Percent Reduction (on day 14) of		
	Rear Paw Swelling	Front	Arthritis Score
Feral, gut fat	70%	33%	52
Feral, back fat	50	11	13
Intensive farmed, gut fat	55	24	15
Intensive farmed, back fat	28	05	0
'Naturally' farmed, gut fat	59	54	25
'Naturally' farmed, back fat	23	51	05

TABLE 3: THERMOSTABILITY OF 2 EMU OILS

Measurements represent mean (±SE) changes in arthritic signs between day- 10 and day- 14 after applying oils (1 ml/kg/day) for 4 days. N=5 rats/gp. Each oil sample treated at 30' or 850C.

Change in arthritic signs (days-10 to 14)

Treatment	Rear Paw Swelling	Fore Paw Swelling	Arthr.Score	Δ wt gm
None	1. 87 (0.31) mm	3.5(0.6)+	3.2(0.3)+	-05
Oil #187-300	0.64(0.17)	2.3(0.3)+	1.7(0.4)+	+08
-850	0.86(0.24)	2.3(0.6)+	2.3(0.4)+	+01
Oil # 200-300	0.34(0.13)	0.5(0.4)+	1.0(0.3)+	+06
-85'	0.32(0.15)	1.2(0.3)+	1.4(0.2)+	+04

TABLE 4: EMU vs. OTHER OILS: TRANSDERMAL EFFICACY FOR INHIBITING ARTHRITIS

Controls were untreated. Oils applied for 4 days only.

Treatment	Dose ml/kg	Percent Reduction (day 14) of Rear Paw Swelling	Front	Arthr.Score
Emu oil[a]	0.5	82%	72%	69%
Rhea oil[b]	1	42	0	26
Lard oil (pig)	2	29	(-19)	18
Fish oil[c]	2	<35	0	15
Olive oil	2	03	0	08
Flaxseed oil	1	39	37	31
Ev.Primrose oil	2	24	10	31

a. From the Cherbourg Aboriginal Community, Queensland, Australia
b. Commercial sample (Pfeffer Farm, St Thomas ON, Canada)
c. Pikasol (Lube AS, Hadsund, Denmark)

TABLE 5: FRACTIONATION OF TWO EFFECTIVE EMU OILS

Emus were from Aboriginal-controlled farms; their fat was rendered locally. A crude fractionation--> approximately 5% (v/v) 'Actives' (applied in 2 milkg olive oil) and 95% (v/v) Residues.

Changes in arthritic signs (das-10-->14)

Treatment/Source	Dose(x4) mg/kg	Rear paw swelling	Fore paw swelling	Arthr. Score	Δ wt (grn)
Olive Oil	1860	1.53 (0.24) mm	2.7(1.1)+	3.2(0.7)+	-06
Ernu/Kalaya (WA):					
whole oil	920	-0.15 (0.18)	-0.3(0.4)+	0.9(0.7)+	+01
,actives'	25	0.65(.39)	1.1(0.3)+	1.4(0.5)+	+02
residue	920	1.27(0.11)	2.8(0.7)+	3.6(1.1)+	-04
EmulCherbourg (Qld):					
whole oil	460	0.46(1.0)	1.3 (0.3)+	1.3(0.3)+	+07
,actives"	25	-0.1(1.5)	0(0.5)+	1.3(0.4)+	+05
	10	0.59(0.23)	1.1(0.6)+	2.7(0.7)+	+06
residue	1840	1.46(0.17)	2.2(1.5)+	2.8(0.8)+	-06

TABLE 6: ARTHRITIS ABLATION: PROOF OF A GOOD OIL?

'Pseudo-adjuvants' were prepared with Mycobact. Tuberculosis (10 mg/ml) and selected Oils.
Inject 0. 1 ml, in tailbase of Dark Agouti female rats. Arthritis scored on day- 17.

Oil	**Arthritis Score**
Olive Oil (00)	3.7+
00 plus E. 0. active*, 10 mg	1.3+
Whole Emu Oil (Cherbourg)	1.7+
Emu Oil Residue*	2.7+
Whole Emu Oil (MtRomance)	3.3+
Flaxseed Oil	3+
Ev.Primrose OH	2.3+

*Active fraction and Residue were prepared from whole Cherbourg emu oil.

NO 11: INTRODUCTION TO EMU OIL: FATS AND OILS IN HUMAN HEALTH (By Maria Minnaar) The Emu Farmers Handbook 1997

EMU OIL COMPOSITION

Appearance

Emu fat is much softer (more "oily") than most other animal fats. Rendered, unrefined emu oil is generally liquid at room temperature, although it may separate into a semi-solid white portion at the bottom of the container, and a yellow-tinged liquid oil at the top. These two portions are called the **stearin fraction** and **olein fraction** respectively, with the stearin fraction containing slightly more saturated fats, and the olein fraction containing slightly more unsaturated ones. The volume of the olein fraction is usually greater. Gentle heating will melt the semi-solid portion, producing a clear oil. However, on cooling, the oil will once again separate.

The colour of emu oil may vary from clear to a deep yellow, with yellow colour being especially prevalent in birds on a diet high in (yellow) corn. The colour of the rendered oil is not necessarily an indication of its quality.

Fatty acids in emu oil

The fatty acid profiles of emu oil, ostrich oil and rhea oil rendered from farmed birds in the U.S. are listed in **Table 8.1**. The profile for emu oil may not be exactly the same for *all* emu oils, since there will be individual variations based on diet, genetics, age, sex, and other factors. For instance, one Australian report indicates that the alpha-linolenic acid level in some Australian emu oils may be several percent higher. However, in spite of some fluctuations, the basic fatty-acid profiles of most emu oils will be similar, and should be distinguishable from those of other species.

Studies are underway to observe the impact of different types of fat in the ration on the composition of emu fat. It would be interesting to find out if the essential fatty acid (EFA) levels - particularly of alpha-linolenic acid - could be increased by making changes to the birds' diet, and if so, what influence this would have (if any) on the oil's activity. According to data available from other animal species, it is possible to influence the composition of animal fat considerably by changes in the diet. For instance, in an experiment to determine the effect of different dietary fat sources on the fat of hogs, the feeds containing oils with a high linoleic acid content (soybean oil, cottonseed oil and corn oil) generally produced a hog fat higher in linoleic acid by several per cent. Also, when the amount of corn oil in the ration was increased from 4. 1 % to 11. 5 %, the level of linoleic acid in the hog fat jumped from 16.8 % to a significantly higher figure of 31.8 % (L. Maynard and J. Loosli, *Animal Nutrition).*

If feed (and fat) intake does affect the composition of emu fat, then the addition of naturally processed flax seed oil, canola (rapeseed) oil or soybean oil should increase the content of alpha-linolenic acid (as well as linoleic acid) in the emu's fat. Also, since the small amount of oil found in the cell membranes of *dark* green plants is over 50 % alpha-linolenic acid, the addition of more green leafy material to the emu's diet - such as kale, chicory, clover and alfalfa - should also have beneficial effects on its fat.

As important as the presence of essential fatty acids, is the **ratio** between them. According to most sources, an acceptable ratio of linoleic to alpha-linolenic acid 'in the diet is between 3: 1 and 10:1. In fact, healthy human body fat contains about 10 % linoleic acid (more in vegetarians) and 2 % alpha-linolenic acid, giving a 5:1 ratio. Emu oil from farmed emus in the U.S. presently contains about a 10:1 to 20:1 ratio, as seen from **Tables 8.1** and **8.2**. The fat of feral (wild) emus in Australia is reported to have higher levels of essential fatty acids.

Another factor which may influence the composition of an animal's body fat is **climate**. Many animals native to cold climates with less sunshine (latitudes which are closer to the north and south poles) have greater amounts of unsaturated fatty acids in their body fats. The same is true for cold-water fish compared with tropical fish. This may be due to the fact that plants (which provide food for animals) in colder climates contain more unsaturated fats. Presumably, the high concentration of unsaturated fats with low melting points is a natural adaptation to keep fats liquid and mobile in the cells, even in freezing temperatures. 2 areas of research which need looking into are:

1. whether or not emus that are moved to colder climates would "acclimatise" by storing more unsaturated fats in their fatty tissues than their warm-climate counterparts (provided they were provided with enough essential fat sources in their diet to do so)
2. whether there are seasonal changes in the composition of emu fat, and if so, during what season the birds should be processed for optimum fat quality.

Sterols and other substances in emu oil

Triglycerides (consisting of combinations of fatty acids and glycerol) are not the only substances found in fats, although they make up the largest portion. Both plant and animal fats also contain an ***unsaponifiable fraction*** (meaning, a small portion that is not made up of fatty acids and therefore, cannot be turned into fatty acid salts or "soaps"). This portion is made up of **sterols** and other compounds, and may contain important substances in very minute quantities. Plant products contain *phytosterols* such as sitosterol and stigmasterol; animal products contain *zoosterols* such as cholesterol.

Any fat-soluble vitamins or provitamins (which are sterols) that happen to be present in a particular fat, are isolated from the unsaponifiable fraction. This "fraction" would of course be equally dispersed throughout the oil or fat, except when artificially separated out for laboratory analysis. Some researchers believe that the activity of emu oil in reducing inflammation is due to an active component, possibly a sterol or related compound, found in this fraction.

To isolate vitamins and other sterols from the unsaponifiable fraction of fats, one method commonly used is **high pressure liquid chromatography** or **HPLC**. Research is still ongoing to find out what sterols and other compounds may be present in emu oil, and what kind of significance these may have.

EMU OIL: ACTIVE PROPERTIES

(a) Effects of emu oil on skin cell growth

A study done at Boston University, Dermatology Department (Dr. M. Hollick, M.D., Ph.D) in 1995 showed that emu oil produced **increased skin thickness and skin growth activity** in mice, compared with a control group treated with corn oil. Enhanced hair follicle growth activity was also noted in the emu oil group.

Further testing on elderly human subjects (Dr. P. Pugliese, M.D., Pennsylvania - ongoing study, 1997) appears to show that emu oil can improve skin thickness in humans also. This is important since the skin can be considered the body's largest organ, responsible for protecting the body against both infection and trauma. One of the effects of aging is thinning of the skin, and this leaves the body much more vulnerable to such damage. Therefore any safe, non-irritating agent that will thicken the skin while maintaining elasticity is highly desirable. In reference to skin health, there are two important things to note about the fatty acid composition of emu oil (see **Table 8.1**):

1. The main fatty acid in emu oil is mono-unsaturated oleic acid (also abundant in olive oil). This also happens to be the main fatty acid of the oil produced by human skin glands. In fact, according to a report by Dr. Leigh Hopkins *(AEA News,* 1997), the overall composition of emu oil is remarkably similar to the composition of human skin oil. The benefit of emu oil when used as a skin conditioner is therefore not surprising.
2. Emu oil is a source of *both* of the **essential fatty acids** (**EFA's**) -about 15 - 20 % linoleic acid (omega-6), and 1 - 2 % alpha-linolenic acid (omega-3). According to Dr. E. Siguel in *Essential Fatty Acids in Health and Disease,* deficiency in linoleic acid can produce a dermatitis characterised by flaky, dry skin. Similar signs have been noted in studies on linoleic acid deficiency in farm animals (pigs and chickens, in particular). Of course, the nutritional problem has to be corrected by ingestion of EFA's in the right amounts, but topical application of oils containing linoleic acid (such as emu oil) will also help the skin problem by direct delivery of linoleic acid to the areas where it is needed the most. In addition, it will promote skin softness.

(b) Emu oil in wound healing

One clinical observation that has been made by many emu farmers is the fast rate of healing seen in injured emus, especially when compared with other animals injured at the same time and in similar ways. Deep lacerations inflicted from kicks during fighting tend to occur mainly on the back and sides of the affected bird (while it is attempting to escape its attacker) and these areas are usually quite well padded with fat. This leads to the question of whether it is the presence of this fat that helps promote healing, or whether rapid healing is due to the bird's metabolism, or perhaps a combination of both.

Since essential fatty acids can be absorbed through the skin, it is possible that many of the reported healing benefits of emu oil, such as **more rapid healing** and **healing with less scarring**, are due to the delivery of essential fats directly to the site where these are needed most. These reports are not merely anecdotal. In an ongoing clinical study at Texas Tech University, Health Sciences Centre (1996/1997) to test the effects of long-term emu oil therapy

(compared with a placebo) on the healing of re-epithelialized bums, there was a significant reduction in scarring and inflammation in the bums treated with emu oil, compared with the controls. In addition, reports from several veterinarians indicate that the application of emu oil to wounds in dogs and horses brings about quicker healing as well as less scarring (including less overgrowth of granulation tissue or "proud flesh"). Emu oil can also be safely used as an udder balm on milk cows with chapped teats.

Note that **contact dermatitis** (skin rash, itching, blistering) such as that caused by poison ivy or other absorbed poisons should NOT be treated with any oily substance, including emu oil, because the poison is oil-based and the addition of any other oils will probably spread the irritant even more. Flush with plenty of water, call the Poison Control Centre and seek medical treatment.

(c) Anti-inflammatory activity of emu oil

In many people suffering from arthritis, which produces swelling and pain in the joints, a gradual reduction in inflammation has been observed when foods rich in omega-3 and omega6 fatty acids are consumed -either in the form of essential fatty acids (alpha-linolenic and linoleic) or their derivatives, such as EPA and DHA (both omega-3 fatty acids) which are found in the oils of cold-water fish and marine animals.

Therefore, when an Australian team of researchers (P. Ghosh, M. Whitehouse et al.) who were investigating traditional Aboriginal medicines learned about the use of emu fat - applied topically - for Joint pain and similar ailments, the first assumption was that the beneficial effect of the fat/oil was due to the presence of essential fatty acids (EFA's) in it. However, in subsequent experiments using the polyarthritis-induced rat model, it was found that although topically applied emu oil was indeed effective in reducing inflammation and swelling (once a solvent such as isopropanol - "rubbing alcohol" - had been added to thin out the oil for better penetration through the skin), the anti-inflammatory activity of the oil was apparently not related to its essential fatty acid content, at least not to the amount of alpha-linolenic acid present. Even emu oil samples which were very low in alpha-linolenic acid, were highly active in reducing inflammation. In a comparative experiment with polyarthritis-induced rats, the activity of some topically applied, EFA-rich plant oils was less than that of lower-EFA emu oils. Chicken fat was also tested, since its fatty acid composition resembles that of emu oil. It showed no activity at all.

The experiments led to the subsequent isolation of an "active fraction" of the oil. Various preparations involving this fraction were later patented (1995 US Patent # 5,431,924), although the active component itself - which is hypothesized to be a sterol, carotenoid or other complex molecule - remains unidentified at the current time. (There is often a time-lag of several years between the discovery of a bioactive substance, and its isolation and identification. This was the case with many of the vitamins, discovered in the first part of the 20th century).

According to the Australian researchers, emu oils vary considerably in their ability to suppress arthritic inflammation, with "active oils" coming both from feral (wild) birds and from domesticated stock. Assuming this to be due to differences between the oils and not variances in the rat model, questions that still need to be answered are:

1. Are the individual differences genetic or environmental?
2. If environmental, do natural substances ingested by the birds play a part - e.g. a particular plant, berry, seed or insect?
3. If genetic, can selective breeding produce more "active-oil" birds?
4. Can simple tests be devised to measure the "activity" of emu oil samples? (A lot more knowledge about the mechanisms by which the oil works will probably be needed first).

These and many other questions are the subject of research on both sides of the equator.

It is important to realise that even if a biologically active component of emu oil is found and isolated, this will not necessarily mean that drug companies will try to manufacture it synthetically and thus make emu oil redundant. There is a growing awareness that for general good health, nutrients and medications obtained directly from their natural sources are usually safer and more beneficial than from chemically synthesised sources. In addition, there may be further health benefits from other components present in the whole, natural product.

Note that some researchers in the U.S. doubt the existence of an "active component" in emu oil, since many of the oil's benefits can in fact be explained on the basis of its fatty acid and triglyceride composition alone. Activity evaluation is part of the ongoing research being conducted by the American Emu Association and other groups.

Marketing emu oil as a therapeutic product

Most NSAID's (non-steroidal anti -inflammatory drugs) have unpleasant side effects such as irritation to the stomach, and may even cause gastric ulcers. If emu oil does have an anti-inflammatory "active component" or an "activity level" which is measurable, it may be possible in the future to market emu oil as a unique therapeutic product: an NSAID without side effects. In the U.S., the FDA (Food and Drug Administration) will not approve a new drug until repeated experiments have proven it to be both **safe** (i.e. the benefits outweigh the risks, at the recommended dosages) and **effective** (i.e. that it consistently out-performs a placebo). Considering the fact that emu oil is a natural product and is therefore subject to some natural variations, it may be difficult to consistently prove "effectiveness" according to rigorous FDA standards. However, successful marketing of emu oil (or emu oil products) is not dependent on FDA registration, nor on future research results which may be years in coming. In the packaging and advertising of emu oil and emu products, two things are important: firstly, *not to make* any claims that are unsubstantiated, i.e. that have no basis in any documented, scientific studies; and secondly, *to make use* of the good results that have in fact been obtained (and documented) in controlled clinical studies.

SETTING STANDARDS FOR EMU OIL

Emu oil guidelines

In 1997, the American Emu Association Oil Standards Team issued a set of International Guidelines as a measurable guide to oil quality. **Table 8.2** is a summary of these guidelines. Any oil which meets or exceeds the criteria provided, is considered of acceptable quality and safe for human use. For each of the criteria, the reference number of its specific AOCS (American Oil Chemists' Society) test has been provided. Because more research still remains to be done on emu oil, the Oil Standards Team chose to issue *guidelines* rather than *standards* to begin with, as some changes and revisions would be likely.

As noted previously, the fatty acid profiles between different emu oils may vary. Therefore, point "E." in the guidelines is regarded mainly as a representative value. Points "F." and "G." are important from an **adulteration** standpoint: if a batch of emu oil has been adulterated with any kind of plant oil, it is likely that the quantity of sitosterol (found in plant fats only) would be higher, and of cholesterol (found in animal fats only) would be lower (Point "G."). On the other hand, if the emu oil were adulterated with any kind of animal oil, it is likely that the triglyceride profile would be different (Point “F”) although this still needs further study.

For processing of oils, most manufacturers recommend non-reactive materials, e.g. glass, epoxy or 300-series stainless steel.

Grading of emu oils

It is difficult to set standards for an oil with beneficial activity when the active component or mechanism of activity is not yet clearly understood. Also, standards may vary according to the purpose for which the oil is to be used. For instance, there may be different sets of standards for oil which will be used in **pharmaceutical/therapeutic** applications in which the oil is considered an active ingredient, versus in **cosmetic** products where the oil is used chiefly for its emollient effect (as in skin creams and hair conditioners). Unrefined oils may be suitable for **veterinary** use (again, with a possible distinction between active and non-active oils), and lower-grade oils for **industrial** use (e.g. lubricants, cutting oils). **Food-grade** emu oils bottled for human consumption would require stricter safety standards during processing (but not necessarily more refining and processing) as well as higher nutritional standards than those applied topically, and should be marked with expiration dates.

The purpose for any standards set or any grading system, whether now or in the future, should be twofold:
1. to maximise the natural, desirable properties of the oil without compromising safety of the product for its end user, and
2. to assure the buyer/manufacturer that any batch of oil purchased for a particular purpose will consistently be of a quality he can depend upon.

EMU OIL: POTENTIAL USES

(a) Skin care

Tests done at the University of Texas Medical School, Dermatology Dept. show emu oil to be non-comedogenic (non-pore-clogging). Other tests demonstrate that it is not a skin irritant. In addition, unlike mineral oil which is a synthetic petroleum-based product currently used as a base in many creams and ointments, emu oil is a natural fat,

and therefore more likely to be compatible with the body. In fact, the fatty acid composition of emu oil - in particular its high oleic acid content - makes it very compatible with human skin oils. Even disregarding the additional benefits of its essential fatty acids, emu oil provides an excellent alternative to mineral oil as a lubricating "base" for topical and pharmaceutical preparations.

Emu oil is combined with many other natural products in skin care preparations, including aloe vera and lanolin.

(b) Therapeutic

If emu oils with consistently high **anti-inflammatory** activity can be developed (e.g. by selective breeding or feeding), such oils may eventually be marketed as a natural, nonsteroidal anti-inflammatory drug (NSAID). If not registered as a "drug" emu oil of this standard can still be marketed as a natural therapeutic product, based on results of past and ongoing clinical tests. These tests have shown emu oil to be beneficial in **increasing skin thickness**, in **wound healing** and in **scar reduction**.

(c) Nutrition

Food-grade emu oil may have nutritional benefits due to the presence of essential fatty acids (EFA's) in it. However, it should be noted that most emu oils currently on the market have a ratio of omega-6 to omega-3 EFA's that is not ideal for human nutrition. To correct the ratio, emu oil might be supplemented with an omega-3-rich oil such as flax oil. The intake of EFA's in the correct balance has been shown to lower excessive blood cholesterol levels in some individuals.

(d) Massage oils

The use of emu oil in massage therapy has many benefits, including skin conditioning and the absorption of EFA's present in the oil. In the massage of re-epithelialized wounds, pressure and mobilisation alone help to stimulate circulation and reduce scar tissue. The simultaneous application of emu oil adds lubrication and healing fatty acids directly to the sites where they are needed the most.

(e) Other uses of emu oil

Early explorers in Australia are said to have used emu oil as a fuel for oil-lamps. Emu oil can also be used in making soap. Industrial applications include using emu oil as a cutting oil and lubricant. It is also an excellent wood conditioner, and has been used by Australian aborigines to oil many boomerangs.

Summary

Until more controlled scientific studies are completed, are documented, are peer-reviewed and finally, are approved by the scientific community, some of the reports about the different properties of emu oil can only be regarded as anecdotal. However, it is important to remember that almost all research begins with anecdotal evidence, which points to the *likelihood* of a certain substance having beneficial effects. In the light of many clinical studies done to date, emu oil can certainly be regarded as generally safe for topical application and beneficial as a skin-care and wound healing agent. These are worthwhile qualities which can be used in the marketing and promotion of emu oil.

NO 12: STATEMENT ON THE THERAPEUTIC PROPERTIES OF EMU OIL (By: Stephen Davies (pers comm) 19th. April 1990)

This statement is based on discussions with Nancy R. Wilson (WA Chemical Centre), Dr. Tan Hansen (UWA Department of Biochemistry), Dr. T. Edkins (Princess Margaret Hospital) and on a search of the literature.

Chemical Laboratories Analysis of Emu Oil

The Government Chemical Laboratories (now the State Chemical Centre) analysed a sample of emu oil from the Wiluna Emu Farm and reported on the analysis in a letter of 29 February, 1980. Nancy Wilson is still at the Centre and was one of those who signed the letter. I spoke to her and to one of her colleagues who told me that:

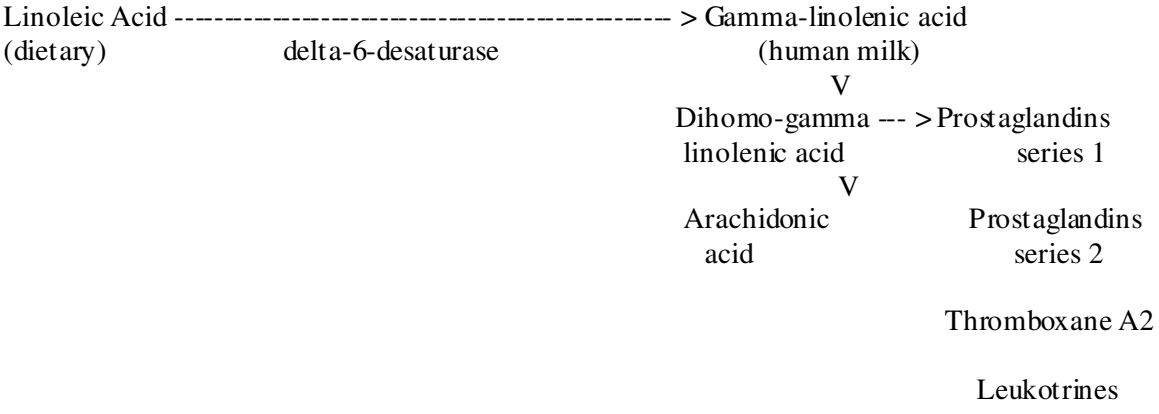
1. The analysis was by gas chromatograph.
2. The analysis would not have been able to identify isomers of the various acids.

The analysis itself showed that only 0.62% of the sample was free fatty acids. Of these free fatty acids, 6.2% was Linoleic acid and 6.0% was Linolenic acid, the two acids that may have some therapeutic properties. The figures given in this analysis differed slightly from those of an earlier analysis (Hilditch, T.P., T.C. Sime and L. Maddison, 1942. Biochemical Journal 36:105.) of emu oil, but only to the extent that could he expected from between sample differences. The absence of Linolenic acid in the 1942 sample reflects its origin; it was from a grain fed zoo bird.

Linoleic and Linolenic acids are essential fatty acids. The human body cannot synthesise them, although it needs them, and must obtain them from food. Thus birds eating different diets wilt have different amounts of these acids in their fat (see comment above re Hilditch analysis). Fully grain fed birds may lack some acids altogether. Fish oils and some plants are known sources; chicken fat can contain three Limes as much of these acids as the sample of emu oil. Different sources have differing proportions of the acids and may have the acids represented as different isomers. The analysis quoted can give no indication of which isomers were present in the sample.

Linoleic Acid and Linolenic Acid

Linoleic acid is a precursor of several chemicals important to the human body, with these general metabolic relationships (from Barber, A.J. 1988. Pharm. J. June 1988:723):



(Note that human metabolism can convert Linoleic acid to gamma Linolenic acid but cannot make either from scratch.)

The administration of Linoleic acid to patients suffering from Multiple Sclerosis has reduced the rate of development of severe symptoms -(Dworkin, R.H, Bates, D, Miller, J.H.D and Paty D.W. (1984). Neurology 34:1441) in those patients in the early stages of the disease but not significantly when symptoms were already severe.

Linoleic acid (70%) and Linolenic acid (9% - as the Garnma isomer) occur in Evening Primrose oil and this has been administered to patients suffering from many metabolic diseases. The rationale is that the metabolic conversion of Linoleic acid to Linolenic acid is inhibited by ageing, diabetes and some other conditions. The administration of Linolenic acid as Evening Primrose Oil is thought to by-pass this block and allow beneficial metabolites of Linoleic acid to be synthesised in the body. Barber (loc.cit.) reviews studies and concludes that beneficial effects of administration of Evening Primrose Oil at least for some patients, are established for the

treatment of premenstral tension, PIS (see above), some skin diseases, some diabetic conditions and alcoholism. Evening Primrose oil has few side effects; mild nausea is reported when caken orally but can be avoided by rubbing it into the skin.

Evening Primrose Oil reduced inflammation in rats but one study of rheumatoid arthritic patients treated with it did not show a significantly beneficial effect.

Emu Oil

Emu oil contains the same two essential fatty acids as Evening Primrose oil, and these could be expected to have the same beneficial effects if administered to humans. However emu oil contains only small quantities compared with Evening Primrose Oil. There are no double blind tests of its effect that 1 can find in the published literature, and we can only surmise by analogy that the acids will have similar effects to those of Evening Primrose Oil. Clinical tests in Perth have given encouraging results but not yet established its therapeutic value.

A Statement

- Emu Oil is a natural, unadulterated product.
- It contains two essential fatty acids that we cannot synthesis.
- Administration of these essential fatty acids has been shown to be beneficial to some patients suffering from metabolic disorders.
- Given its penetrating properties, the application of Emu Oil to the skin will supplement the supply of these essential fatty acids.

NO 13: APPENDIX B The emu - A BREAKDOWN OF ITS' MEDICINAL PROPERTIES (By St George Marketing Solutions Marketing Plan for Emu Oil, grade 1 (1997)

BACKGROUND

The origin of the use of emu oil is believed to have begun when the emu fat was collected by aborigines. They hung the emu skin from a tree and collected the oil, or alternately they wrapped the skin around a sufferer and left them in the sun, allowing the oil to liquefy and penetrate the skin.
Early settlers corroborated this by using it on themselves, their animals and their riding tackle.

The Australian aboriginal people ascribed great medical powers to emu oil's body fat as:

- *remedy for skin ailments*
- *skin protectant and sun screen*
- *burn treatment and liniment An arthritis treatment and liniment A skin moisturiser An epithelialiser of wounds; reduces scar tissue and soothes swollen wounds after surgery or for lacerations*

The emu is considered by many scientists to be an improbable bird; it cherishes water, carries twenty pounds of fat and lives in the rugged outback in temperatures above 37 degrees Celsius.

Adult emus have incredible recuperative abilities from shock and wounds not normally observed in nature.

THERAPEUTIC AND COSMETIC PROPERTIES OF EMU OIL

Emu oil contains the following beneficial substances:

* **VITAMIN-E** an anti-oxidant and healing agent
* **VITAMIN**-A a known skin repairer
* **TERPINES** an antiseptic
* **SAPOGENS** skin softener
* **OLEIC ACID** (1)

FEATURES	BENEFITS
A skin cell regenerator and preserver	Besides providing local anti-inflammatory effects, it can also induce a long lasting state of pain relief in the local area.
An epidermic transporter of bio-active compunds that conducts them through the layer of the skin down to muscle tissue	Can be combined with enhancers or drugs for topical application of treatments of medicines only previously administered internally (often with side effects). A breakthrough in duration and validity of moisturisers, balms and creams due to the penetrative consequences of the oleic acid in the emu oil.

* **COMEDOGENCITY** (pore clogging) (2)

FEATURES	BENEFITS
Unlike other oils emu oil does not clog up the pores of the skin or cause acne	More effective skin treatment which will enable the emollients to penetrate the skin's surface and have greater impact without greasy residue, a boon for the cosmetics industry. Similarly, it is more active than water based creams which do not penetrate the skin barrier.

*** FATTY ACID ANALYSIS / EFFECTS ON HEART DISEASE AND ARTHRITIS** [3]

70% of all acids in emus are of the unsaturated variety; less than 30% are polyunsaturated fats with the rest in monounsaturated fats. Emu oil contains the following essential fatty acids (acids that our bodies do not make) necessary for good health and productive growth.

FEATURES	BENEFITS
Oleic acid; the largest primary fatty acid found (benefits already discussed).	These findings are consistent with the recommendations for a heart healthy diet and have a beneficial effect on cardiovascular disease.
Omega 6 fatty acids; necessary as building blocks for very powerful compounds, prostaglandins, as certain diseases can cause an unbalance of prostaglandins in the body	The balancing of prostaglandins in the body serves to control and ease the effects of arthritis.
Omega 3 fatty acids; another important acid usually found in fish oils. Omega 3 contains EPA& DHE	EPA & DHE are again critical in the fight against heart disease.
Linolenic acid; present in large quantities in emu oil and is known to ease muscle ache, joint pain and have anti-inflammatory properties	The linolenic acid in emu oil has anti-inflammatory properties that will substantially reduce the pain and inflammation of arthritis (rheumatoid and osteoporosis).

* **BACTERIOSTATIC TESTING** [4]

FEATURES	BENEFITS
Emu oil has been tested for the following bacteria and found no growth nor indeed presence in the fat; anaerobic bacteria, fungus, salmonella, shigella, staphylococcus, streptococcus, E coli. It can be concluded that emu oil does not promote the growth of bacteria.	An unusual and remarkable quality leading to projected and already executed applications in many commercial products instead of chemical based preservatives and stabilisers presently used in creams, make-up and even food: eg; hydrogenated vegetable oil for food and liposomes in the cosmetics industry.

* **LONG LIFE PROPERTIES** [5]

FEATURES	BENEFITS
Emu oil is stable at room temperatures, does not readily oxidise and has not deteriorated in storage after two years. Furthermore, emu fat does not subscribe to normal definition of animal fat but rather shares more in common with some seed oils.	Potential as a natural product stabiliser and preserver.

* **EPITHELIALISED <u>WOUNDS</u>** [6]

FEATURES	BENEFITS
Emu oil has demonstrated scar reduction and anti-inflammatory action. Emu oil is sterile and hence can be used in an open area of the skin.	Speeds up the healing process from surgery and burns by reducing inflammation, preventing scarring and soothing pain. It reduces irritation in eczema, the scarring of keloids and has advantages in skin grafting.

*** HAIR REGROWTH** [7]

From tests using Kalaya a processed emu oil on mice the following was found

FEATURES	BENEFITS
There was a 20% increases in DNA synthesis, stimulated hair and skin growth and hair follicles were more robust	Stimulates hair regrowth.

*** SKIN MOISTURISER** [8]

Initial testing suggests that emu oil has remarkable pwoers for moisturising based on its ratio of C-16 to C-18 unsaturated components and the stereochemistry of the C-18 oleic moiety.

FEATURES	BENEFITS
It is able to enhance the skin's upper layers to hold onto water, penetrate the epidermis and stimulate its rete ridges which would enhance the thickness of the dermis	Transforms rough dry skin to a smooth and healthy appearance. Can reverse the ravages of aging. Can offer similar benefits to hair and nails.

*** EMULSIFIER** [9]

FEATURES	BENEFITS
Emu oil is a good emulsifier being able to blend two products together naturally	Will have many applications with cosmetics and creams. Can combine with many pharmaceutical ingredients to improve therapies eg. Aspirin for pain relief.

SOURCES OF REFERENCE OF RESEARCH

[1] OLEIC ACID based on research by Dr Margaret Craig-Schmidt Associative Professor of Department of Nutrition and Food Science at Auburn University Alabama USA.

[2] COMEDOGENCITY: Dermatology Department, Occupational Dermatology Laboratory at the University of Texas Medical School at Houston in 1993.

[3] FATTY ACIDS; Dr Craig-Schmidt as above, Dr Michael Wellesley Whitehouse PhD in Chemistry Univ Oxford and MP Ghosh for article "Evaluation of Emu Oils for Anti-finflammatory Activities".

[4] BACTERIOSTATIC TESTING; Karen Davis (medical technologist and biochemist) researched for Outback Emuzing Ranch in British Columbia in Canada, 1995 from Internet; //www.ark.com/-emuzing/emuoil.html.

[5] LONG LIFE PROPERTIES; Ms Chris Burke of Epicure Products Marketing from World Emu Conference Programme, 1996 pp24-25.

[6] EPITHELIALISED WOUNDS; Dr GR Hobday from "Emu Oil – A Clinical Appraisal of this Natural and Long Used Product".

[7] HAIR REGROWTH; a clinical study by Michael Holick, MD, PhD, Professor of Medicine, Physiology, and Dermatology at Boston University School of Medicine.

[8] SKIN MOISTURISER; Study of Dr Alexander Zemtsov Editor of Skin Research and Technology, for Emu Today and Tomorrow, v15 No 1. By Nelson, Heide and Ardell, 1996.

[9] EMULSIFIER; Dr A Zemtsov, as above.

NO 14: DOCUMENTATION (pers comm. Supplied by Steve Birkbeck – Principal Mt Romance)

MEDIA RELEASE:

EMU OIL RECOGNITION

AUSTRALIAN EMU FARMERS BREAKTHROUGH
GOVERNMENT CERTIFICATION OF UNIQUE THERAPEUTICS

International pioneer of emu oil based products is an Australian company Mt Romance. This week it has recorded a major achievement in it's desire to retain the leading role. Through cooperation with five Australian emu farm groups it has had official Australian Government recognition and listed approval for a range of therapeutic compounds that use emu oil as a base in the fight against arthritic pain.

The official recognition of emu oil based products is the first step in getting emu oil recognized as a compound that has the capacity to penetrate and assist in the relief of pain, inflamed joints and numerous other skin tissue and join disorders. Preliminary research by Mt Romance Australia Ply Lid has indicated that emu oil has anti-inflammatory, cellular regenerative and penetrative qualities.

The Federal Government approval is the result of applying knowledge generated by Mt Romance through five years of research here and in Prance, the worlds leading nation in regard to skin and body care.

The approvals mean that today MT Romance has seven listed therapeutics to compliment over 150 cosmetics that it sells in Australia and Internationally. With six applications pending for additional therapeutic products for arthritis, sun care, skin disorders and muscle strains, Mt Romance is maintaining it's lead in the world of emu oil.

Based upon a commitment to product excellence, retail support and technological innovation, Mt Romance has achieved outstanding sales growth performance over the past six years. With the incorporation of Mt Romance France in 1994, the first Australian exports of cosmetics to France have been recorded. This success in France in testimony to positive company discretion and quality of products.

Over 90% of all Australia's expensive cosmetics are imported, the majority taken from powerful French and American multi-national giants. The sale of cosmetics to the French market by Mt Romance has provided proof to the Australian economy, and to the recession hit farmers of the bush that we can and must add value to our raw commodities.

17 January 1995

MEDIA RELEASE:

EMU OIL RECOGNITION
AUSTRALIAN TO LISE THE EMU TO THE U.S.A.?

With the Australian farming sector still reeling from near mortal blows applied by the financial interests of the American cattle industry in recent weeks, our balance of trade is now being threatened on a topic close to the heart of Australia, the emu.

Today there are over 750 emu farms in Australia. Emu farming attracted international attention in 1987, and as a result of this, the United States has invested heavily into the farming of emus. Today the U.S.A. has an industry as large as Australia's.

The population size, investment might and public belief in the qualities of the emu in the USA are threatening to dwarf the Australian emu industries growth over the next five years.

Emu oil is seen as the area of greatest profit in the emu industry. Well known cosmetic firms in New York (eg. Donna Karan) and medical organizations in Texas are investing large sums in an attempt to profit from the therapeutic properties of emu oil.

The Australian emu industry is now fighting a race against time to maintain it's siupremacy as the world's leading producer and marketer of emu oil based products. Mt Romance Ausralia Pty Ltd is the acknowledged pioneer and leader in the international market and has recently successfully expanded it distribution base of sunscreens and therapeutics of emu oil into the chic ski resorts of the French Alp's.

ADDITIONAL INFORMATION:

*EMU OIL ANALYSIS FROM USA

	Anisdine Value	Peroxide value	Totox value	Odour descrip.
Raw Oil (Oct)	2.61	6.39	15.39	Str. Animal/game note
Deodorised & clarified (Dec)	20.81	25.17	71.15	V slight protein note
Deodorised & clarified (10776)	7.00	4.78	16.56	Background protein note
Deodorised & clarified (30781)	20.27	7.57	35.41	Background rancid note
		80.0		

Note: TOTOX Anisdine Value + 2 (Peroxide Value)

Processing the raw oil eliminates the animal/game odour leaving a protein note in the oil. The D&C oil from December 1992 does not smell rancid though there is still a slight protein note. Batch 10776 has a stronger background note than the December oil. Batch 10781 has no detectable protein note, but has a slight rancid note. Rancidity is due primarily to volatile aldehydes and presents itself as a "smarmy", suffocating odour.

Anisdine value measures aldehydes in the oil. These less volatile aldehydes are left over as a result of the degradation of peroxides in oil. Peroxide value measures oxidised bonds in the chains of fatty acids. Peroxides rapidly break down to yield shorter chain fatty acids which may be volatile, and volatile and non-volatile aldehydes, ketones and other products which are often odoriferous of flavourful (both pleasant and unpleasant). Totox values are calculated from PV and AV, and the Totox value serves as a gauge of how far from the near zero value of an ideal oil a real oil measures. The higher the number of any factor, the worse the oil is damaged for that property. Since peroxides degrade leaving aldehydes behind, the Totox value permit rank ordering the oils.

The rule of the thumb guidelines for each value are that Totox value are that Totox values for fresh oils should be below 10 units; Peroxide value should be below 7 units or the oil is considered rancid; and the Anisdine value should be below 4 units for fresh oil. The guidelines are used to evaluate how much beyond bland the oils have become. Peroxides are most readily broken down by application of heat, then moisture, and finally ultraviolet light.

Comment:

The saponification equivalent and fatty acid composition of this sample are very similar to those obtained by Hilditch, Sime and Hadsison who observed that emu fat "shows considerable general resemblance to depot fats of the larger land animals". Sample deterioration as evidenced by the rancid smell, may account for the higher iodine value and some of the differences between the fatty acid figures.

The ranges of figures for the iodine values and saponification equivalents for various groups of fats and oils are as follows:

Group	Examples	Iodine Value	Saponification equivalent range
Animal fats	Butter, dripping, lard	30-70	230-290
Non-drying oils	Olive oil, arachis oil, almond oil	80-110	280-300
Semi-drying oils	Cottonseed oil, soya oil, sesame oil	80-140	288-300
Drying oils	Linseed soil, sunflower oil	125-200	288-300

Emu fat has a similar iodine value, saponification equivalent and fatty acid composition to that of neatsfoot oil which is rendered from the feet of cattle. Neatsfoot oil is a valuable lubricating oil for delicate machinery and is largely used in leather dressing.

Because of the predominance of oleic and palmitic acids in emu fat, it has not the drying properties required by the paint industry. It has possible uses in soap making, liniments, leather dressing, lubrication and the manufacture of wetting and emulsifying agents and detergents.
As discussed with your Mr D Petterson a copy of this report has been forwarded to S Davies of CSIRO Wildlife Research, Boya.

References:

M R Bean, "Utilisation of fats", Harvey London, 1938.
L Howitsch, "Chemical Technology and analysis of Oils fats and Waxes", MacMillan and Co., Ltd., London 1914.
D Swern (ed) Bailey's "Industrial oil and Fat Products", Interscience Publishers, 1964.
D Pearson, "The Chemical Analysis of Foods", Churchill Livingstone, 1976.

NO 15: EMU OIL ANALYSES (pers comm. Supplied by Tony Golding – Principal Emu Vertica)

Emu Vertica
6th Floor, EPA House
1 Mount Street
PERTH 6000
Attention: Nerina McCaughan

REPORT ON FIFTEEN SAMPLES OF EMU OIL RECEIVED ON 27TH NOVEMBER, 1990
EMU OILS

LAB NO. 90B	19199	19189	19190	19191	19192		
SAMPLE	1	2	3	4	5	MEAN	STANDARD DEVIATION
	% FATTY ACID IN OIL PROCESSED						
FATTY ACID							
C14:0 Myristic	0.3	0.4	0.3	0.3	0.3	0.3	0.01
C16:0 Palmitic	21.9	21.9	21.9	21.9	22.0	21.9	0.03
C16:1 Palmitoleic	3.6	3.6	3.6	3.6	3.6	3.6	0.02
C18:0 Stearic	9.4	9.2	9.2	9.3	9.3	9.3	0.04
C18:1 cis Oleic	48.8	48.8	48.4	48.5	48.5	48.5	0.14
C18:1 trans Elaidic*	2.2	2.1	2.0	2.1	2.1	2.10	0.04
C18:2 Linoleic	11.7	11.6	11.6	11.6	11.6	11.6	0.05
C18:3 Linolenic	0.7	0.7	0.7	0.7	0.7	0.7	0.01
C20:1 Eiconsenoic*	0.4	0.4	0.4	0.4	0.4	0.4	0.00

EMU GUT FAT TAKEN FROM BIRD AND NOT PROCESSED

LAB NO. 90B	19193	19194	19195	19196	19197		
SAMPLE	1	2	3	4	5	MEAN	STANDARD DEVIATION
FATTY ACID							
C14:0 Myristic	0.2	0.3	0.3	0.3	0.3	0.3	0.2
C16:0 Palmitic	20.0	21.4	22.1	20.8	20.2	20.9	0.76
C18:0 Stearic	9.6	11.4	10.8	9.0	9.9	10.1	0.84
C18:1 cis Oleic	50.9	46.7	50.1	49.1	50.6	49.5	1.50
C18:1 trans Elaidic*	2.2	1.7	2.0	2.2	2.1	2.0	0.18
C18:2 Linoleic	12.0	13.8	9.3	12.9	12.0	12.0	1.50
C18:3 Linolenic	0.7	0.8	0.5	0.6	0.7	0.7	0.10
C20:1 Eiconsenoic*	0.5	0.4	0.4	0.5	0.5	0.5	0.03

*Tentative identification
Other unknown fatty acids present were less than 0.2%.

BODY FATS TAKEN FROM BIRD AND NOT PROCESSED

LAB NO. 90B	19198	19199	19200	19201	19202		
SAMPLE	1	2	3	4	5	MEAN	STANDARD DEVIATION
FATTY ACID							
C14:0 Myristic	0.3	0.4	0.3	0.3	0.3	0.3	0.04
C16:0 Palmitic	20.8	26.0	21.0	20.3	20.3	21.7	2.16
C16:1 Palmitoleic	3.0	5.2	2.9	4.0	3.1	3.68	0.85
C18:0 Stearic	9.7	9.0	9.8	9.0	8.7	9.2	0.42
C18:1 cis Oleic	49.5	44.8	47.1	46.8	49.7	47.6	1.83
C18:1 trans Elaidic*	2.1	2.2	1.8	1.6	2.3	2.0	0.26
C18:2 Linoleic	12.1	10.2	14.1	15.1	12.8	12.8	1.67
C18:3 Linolenic	0.8	0.6	0.9	0.8	0.6	0.8	0.10
C20:1 Eiconsenoic*	0.4	0.3	0.4	0.5	0.54	0.4	0.07

* Tentative identification
Other unknown fatty acids present were less than 0.2%.

NO 16: EMU OIL ANALYSES (Supplied by Peter Thompson – Principal TJURINGA Emu Products)

re: Oil Research on Tjuringa Emus.

Please find enclosed summary of results of emu oil research conducted by Michael Whitehouse on Tjuringa emus and a few other samples as well. These results, like most of the current research are, as yet unpublished. However finding a better reference for you has not been possible as Michael's paper for the Pharmaceutical journal is still in the pipeline. I therefore hope this unpublished data will satisfy your needs.

To summarise the message as I see it, these results show that those who believe nutrition is the most important variable affecting the antiinflammatory qualities of emu oil are wrong. In this same vane to suggest that wild birds have better oil is also unsupported by these initial findings. I am not suggesting that nutrition is not important. However it needs to be considered with the other variables including age and sex for example.

My belief is that the research so far undertaken by Michael supports the view that there is a very large genetic variation in the antiinflammatory effects of emu oil and that we should first of all be trying to identify which and where these birds are.

Having identified the birds we then need to determine whether this quality:

- is heritable;
- changes throughout the year;
- is affected by rendering techniques;
- is affected by age;
- is affected by sex;
- is affected by nutritional regime.

We are currently looking at comparisons between birds that originated from Cherbourg in QLD and Kalaya in WA, to see whether genetics is more important a consideration than the other factors including age, sex and nutrition. These are the factors that we were looking at in the first trials and following are the results of that research. Also included with these results are the results of other emu fat samples that have been submitted from people like yourself.

If the results of these trials are confirmed with ongoing and further urgently needed research, then Australia must surely have a significant advantage over all other countries farming emus in the world. Our larger genetic base gives us a far larger population to select from.

EMU OIL RESEARCH DETAILS

ID	Expt/ Reference	LWT (kg)	Age (yrs)	Sex	Origin (C/WA)	Nutritional Regime	Results(*): Assessment Criteria		
							A	B	C
Tjuringa Emus									
200 - First	27/1/97	42	2	M	WA	R1	85	75	81
- Unheat	269						82	80	69
- Heated	269						83	60	56
- Oral	269						79	31	69
197	15/1/97	47	2	M	WA	R2+F	70	54	70
195	239	42	2	M	WA	R2+F	65	52	44
192	Rancid	38	1	U	C	R1	-	-	-
190	239	35	1	U	C	R1	65	55	54
187	234	37	1	U	C	R2	80	74	54
	269						66	34	47
	269						54	34	28
184	234	40	1	U	C	R2	95	90	64
181/PSP	272	43	3	M	C	R1	84	56	75
179	234	39	3	F	C	R2	44	35	29
Property Tj-Kg:	236		1-3	U	C	Several	83	94	59
(batch) -Oral	234						43	13	4
-Actives	27/1/97						81	70	42
Property K1:	27/1/97		1	U	C	R3	10	30	23
	27/1/97		2	U	C	R3	57	50	27
Property G2:									
(batch) - Gut	15/1/97		1	U	C/WA	R4	55	24	15
- Bum	15/1/97		1	U	C/WA		28	5	0
Property C3:									
(batch) - Gut	239		1	U	C	R7	63	41	54
- Bum	239		1	U			57	97	43
Property N4:	272			U	C	R5	97	100	100
Wild QLD - Gut	236		?	U	?=C	Wild	41	43	34
- Bum	236			U			46	80	46
Aged Kalaya Oil	269		?	U	WA	R6	100	100	72
Commercial	234		?	U	WA	Several	15	23	0

Where: (*) Scoring ranges from a low of 0 to the highest of 100
U = Unsexed
M = Male
F = Female
C = Cherbourg
WA = West Australian

NO 17: EMU OIL INTAKE OBSERVATION. (Supplied by Peter Thompson – Principal TJURINGA Emu Products & Stephen Schmidt – Principal TRYIT Emu Farm.)

Summary: ***An observation was undertaken of the effects of emu oil taken orally by 540 mixed age and sex respondents. These respondents were those that responded of the more than 2,000 volunteers, that were given a free three-week supply of emu oil capsules.***

The results show that most people have been able to consume emu oil without any short-term negative effects. However there were two of the participants that had to discontinue their involvement in the observation because of the reaction they had to the oil.

52% of people reported benefits ranging alleviating pain associated with arthritis; improvements in skin condition; reduction in blood sugar levels for some diabetics; improvements in general feeling; and other benefits including improved blood circulation; reduction in blood pressure and cholesterol levels; improvements in angina and rheumatism; elimination of menopausal "hot flushes", pain and headaches; improvements in eye sight; wound healing; appetite and improvements in bowel movements.

This observation shows that emu oil taken orally has the potential to add to the range of anecdotal attributes reported in the literature. Whilst it would appear that the oil can be taken without short term negative side effects, there will be some people that will react adversely and be unable to consume the oil orally and there are others that will receive no benefit.

Introduction:

Anecdotal reports of the healing qualities of emu oil are well documented in the literature (Hobday 1994, Bennett 1860, Leichhardt 1845 and Low ????). As well as this there are scientific studies which have been conducted (Whitehouse et al 19 , Snowden 19 , and) and other research currently being undertaken at the Women's Childrens Hospital in Adelaide (Ferrante et al 2002).

Most of the evidence and research relates to emu oil being applied externally to alleviate pain and suffering associated with muscular problems and skin conditions.

In recent years there has been an increasing interest in (and demand for) emu oil which can be consumed orally in capsule or liquid form. However there has been no studies undertaken to determine what happens to people taking emu oil orally.

What does it do? Is it Safe? How much do I take and how frequently? Is all oil the same or are some oils better than others?

The logical place to go for answers to these questions is the local Doctor. However when this has happened, in most cases, doctors are unable to provide answers.

It was for these reasons that an emu farmer and supplier of emu oil products in Southeast Queensland decided to conduct his own observation. As he was selling a lot of emu oil in bottles and as capsules for people to consume he decided to see if he could get a large number of people to take emu oil for a three week period and provide him with feedback on the results. Because he was getting a lot of interest from diabetics in his products he decided to advertise a three week free course of emu oil to diabetics anywhere in Australia who would be prepared to "give it a go".

Procedure:

Consequently in January 2001 the project commenced and over the next 12 months over 2,000 people from all over Australia (but mostly in the eastern states) were sent either 126 or 147 one ml emu oil capsules. These were intended to be consumed at the rate of two capsules, three times per day.

All of these people were also sent a form which had been deigned to allow people to easily document their responses and (as diabetics were the original target audience) to also record their daily blood sugar levels.

Half way through the period it was decided that the form was a bit complicated and it was modified to allow people the opportunity of filling in only their pre-breakfast blood sugar level. However it was also expanded to allow participants to answer "Yes" or "No" to 6 Questions. These were:

1. Do you have Circulation problems?
2. Did you find Improvement?
3. Do you have Pain?
4. Did you find Improvement?
5. Do you have eye problems?
6. Did you find Improvement?

By the 1 January 2002, 540 people had returned their forms and the breakdown of those respondents by age, sex and weight is detailed in Table 1.

Table 1: Breakdown of Respondents.

		Number	
First Format		243	
Second Format		297	
TOTAL		540	
		(No)	(%)
Sex	Male	281	52%
	Female	206	38%
	Unspecified	53	10%
Age	Average	60	
	Maximum	94	
	Minimum	16	
Weight	Average	87	
	Maximum	224	
	Minimum	42	

Results:

Having obtained the details of the respondents, the results were then analysed in three main areas.

- Assessment of Comments.
- Answers to Questions
- Analysis of Blood Sugar Levels.

Section 1: Assessment of Comments.

Table 2 presents a summary of the results with the first figure identified being the 237 respondents who reordered and paid for a second lot of tablets. This number represents 44% of all respondents and is more than the number of people making "positive comments", and shows that a significant number of the people who received emu oil tablets were prepared to pay real money to buy more.

Table 2: Summary of Responses to Comments.

	(Number)	(%)
Number of respondents who reordered	237	**44%**
1. Arthritis	46	
2. Skin Improvements	16	
3. Diabetes Improvements	56	
4. General Health	39	
5. Other Positive Attributes	34	
TOTAL POSITIVE COMMENTS	**191**	**52%**
6. Negative Comments	**32**	**6%**
7. No Change	48	9%
No Comment	180	33%

It shows that of the 540 respondents 33% made no comment and 9% believed that there had been "No Change" in their health. This left 58% of respondents whose comments were grouped according to common themes as shown in Table 2. (The actual responses are all detailed in Appendix A.) By taking the 6% of negative comments away from the balance it means that more than half the respondents (52%) reported positive effects from the emu oil capsules.

1.1 Arthritis:
Whilst this observation was targeting Diabetics one of the most interesting responses was the 46 responses of people that believed taking emu oil orally assisted in reducing arthritic and other similar pain. Some of these responses are quite spectacular (cf. Appendix A in 1. Arthritis Id 122).

1.2 Skin Improvements:
16 respondents reported improvements in their skin condition, which ranged from generalised statements stating that their skin had improved to more specific responses that identified skin softening.

1.3 Diabetes Improvements:
At the outset of this observation it was suspected that emu oil would contribute significantly to reducing blood sugar levels of diabetics. This is covered in more detail in Section 3, which shows that this was not in fact the main result. However whilst many diabetics did not report any change in their blood sugar levels (BSL's) there were 56 positive responses to the effect of the emu oil on their diabetes. This represents about 10% of all respondents and consequently would indicate that emu oil would not appear to be a cure or of benefit to most diabetics. It is also possible that there is a placebo effect in this group of respondents, who were no doubt hoping that the emu oil would enable them to replace synthetic chemicals with a natural alternative.

1.4 General Health:
"General well Being" is a hard aspect to quantify, however so many respondents (39) identified this component that it required a separate grouping. Whether the emu oil has acted like a tonic or has helped eliminate other areas, which could be identified with a measure, was not determined in this study. Based on other comments that identify responses like reduced blood pressure, cholesterol and triglycerides for example it would be interesting to know whether these were the sorts of measurable responses that these respondents were experiencing.

1.5. Other Positive Attributes:
This group contains a whole range of different responses which because they were only mentioned a few times did not warrant the creation of a separate identifiable group. It includes positive experiences with improved blood circulation; reduction in blood pressure and cholesterol levels; improvements in angina and rheumatism; elimination of menopausal "hot flushes", pain and headaches; improvements in eye sight; wound healing; appetite and improvements in bowel movements.

1.6 Negative Comments:
Whilst the bulk of the responses to this observation are positive it would have been surprising if there were not some negative aspects. The most significant comments being from 2 respondents who reacted to either the oil or the capsules that contained the oil. Whilst there were only two of these reported cases, it is worth reflecting that the emu oil is derived from the birds fat and some people are allergic to animal fat. Most of the reported negative comments relate to the effects of emu oil on Blood Sugar Level's and not on any major health feeling of discomfort. Of those that did report discomfort in their initial reaction to the emu oil, it is interesting to note that this disappeared after their bodies became acclimatised to the oil. Other reported negative comments related more to the way the product was presented (e.g. 'Pills are too large") or the price, which are really not a reflection on the emu oil.

Section 2: Answers to Questions.

The reason for changing the response form half way through the observation was, not only to simplify the answering, but also to expand on the feedback. Because the first 240 respondents did not have the option to complete these questions the percentages shown in Table 3 are based on the 297 respondents who were in a position to answer these questions.

Table 3: Answers to Questions concerning Circulation, Pain & Eye Problems.						
	Yes		No		Unanswered	
	(Number)	(%)	(Number)	(%)	(Number)	(%)
Do you have Circulation problems?	105	35%	164	55%	28	10%
Did you find Improvement?	45	43%				
Do you have Pain?	142	48%	129	43%	26	9%
Did you find Improvement?	70	49%				
Do you have eye problems?	124	42%	148	50%	25	8%
Did you find Improvement?	28	23%				

The most notable response here further supports the results in the Arthritis Section 1.1 discussed above. Almost half (48%) of these respondents reported experiencing pain and half (49%) of these obtained relief from the emu oil capsules.

One third of the respondents reported circulation problems, which was improved by the consumption of emu oil. The response of problems with sight was the least significant with only 23% of the 124 people who experience eye problems reporting improvement in sight from the emu oil capsules.

Section 3: Analysis of Blood Sugar Levels.

As this observation was originally established in the expectation that diabetics would be reporting that emu oil had reduced their BSL's, it was rather disappointing for those diabetics that did not report an improvement. However as was mentioned in Section 1.3 Diabetes, there were 56 positive responses.

Table 4: Diabetes Blood Sugar Readings.							
	20 Day Results				27 Day Results		
Day	Number	Mean	5 Day Moving Average		Number	Mean	5 Day Moving Average
1	423	8.5			77	8.5	
2	414	8.3			73	8.6	
3	424	8.3			78	8.6	
4	424	8.4			79	8.5	
5	430	8.4	8.4		81	8.7	8.6
6	429	8.3	8.3		81	8.3	8.5
7	430	8.3	8.3		80	8.4	8.5
8	427	8.3	8.3		81	8.2	8.4
9	427	8.3	8.3		79	8.5	8.4
10	427	8.2	8.3		79	7.7	8.2
11	425	8.2	8.2		79	8.2	8.2
12	426	8.1	8.2		80	7.9	8.1
13	428	8.0	8.2		81	7.8	8.0
14	431	8.0	8.1		81	8.1	8.0
15	428	8.2	8.1		80	8.4	8.1
16	428	8.0	8.1		80	8.0	8.1
17	427	8.1	8.1		79	8.4	8.1
18	429	8.0	8.1		80	8.0	8.2
19	429	8.1	8.1		80	7.7	8.1
20	427	8.1	8.1		80	7.8	8.0
21					81	8.0	8.0
22					81	8.0	7.9
23					81	7.9	7.9
24					76	7.5	7.8
25					77	7.5	7.8
26					75	7.8	7.7
27					75	7.9	7.7

To ascertain the result of emu oil on the largest population possible Table 4 shows the results of that amalgamation. This Table presents the results of daily pre-breakfast Blood Sugar Levels (BSL's) for between 73 and 81 people over a 27 day period. It also looks at the results of between 414 and 430 people over a 20 day period. The number variation is due to the inclusion of respondents who had only 26 and 19 days respectively of results. (all respondents with more than one days missing records were excluded from the observation. This has enabled the maximum population to be included to provide these indications, but has not compromised the integrity of the data included.

The data is also presented as a 5 Day Moving Average to smooth out any peaks and troughs that occur as a result of day to day fluctuations in the morning BSL's.

The result of this analysis partly supports those respondents who said the observation was not long enough. Whilst both periods show a fall in the BSL, the fall is greater with the longer time period:

- the 20 day period shows a reduction from 8.5 (or 8.4 for the 5 day moving average) down to 8.1
- the 27 day period shows a reduction from 8.5 down to 7.9 (or 8.6 for the 5 day moving average down to 7.7).

Whether this downward trend would continue over a longer time period and whether this reduction is significant is beyond the scope of the Author to comment.

Discussion:

From the results of the respondents to this observation, it is confirmed that emu oil has a wide range of pharmaceutical applications. Whilst this fact has been documented for many years, it is interesting to see that people consuming emu oil orally, as opposed to externally as a rub, reported similar responses to those which have been reported anecdotally by Hobday (1994) and others (Bennett 1860, Leichhardt 1845 and Low ????).

The major areas of benefit were grouped as follows:

- alleviating pain associated with arthritis;
- improvements in skin condition;
- reduction in blood sugar levels for some diabetics;
- improvements in general feeling; and
- other benefits.

The range of responses in the last category was quite wide and included reports of benefits to:

- blood circulation
- reduction in blood pressure and cholesterol
- improvements in angina and rheumatism
- elimination of menopausal "hot flushes", pain and headaches
- improvements in eye sight
- wound healing
- appetite and bowel movements.

The respondents to this observation also show that emu oil is NOT a "cure all" for every health problem encountered by human beings! Whilst 52% of respondents reported beneficial aspects of taking emu oil 33% did not respond and 9% reported no change (Table 2).

One of the most important findings of this observation is that not all people can consume emu oil. Whilst a number reported negative side effects, two of the 540 respondents reported that they were unable to take the emu oil, as it caused them to become ill (Appendix B). As not all people can eat the same things it is not unexpected to find that some people would react negatively to consuming bird fat.

It is however interesting to note that most of the reported negative comments relate to the effects of emu oil on Blood Sugar Level's and not on any major health feeling of discomfort. Of those that did report discomfort in their initial reaction to the emu oil, it is interesting to note that this disappeared after their bodies became

acclimatised to the oil. Other reported negative comments related more to the way the product was presented (e.g. 'Pills are too large") or the price, which are really not a reflection on the emu oil as such.

It is important to state in concluding that this was not a trial but an observation, which will hopefully substantiate the need for more detailed and comprehensive trialling of the medicinal qualities of emu oil to be undertaken. The anecdotal Australian aboriginal evidence about the beneficial aspects of emu oil relates to external application.

This observation shows that emu oil taken orally has the potential to add to the range of attributes reported in the literature. Whilst it would appear that the oil can be taken without short term negative side effects, there will be some people that will react adversely and be unable to consume the oil orally.

Author's Note:
In conclusion the author of this paper was not totally surprised at the results to this observation. I routinely and regularly use emu oil to alleviate pain and suffering from sprains and bruises as well as skin irritations including dry skin, tinea, sunburn and in some cases for wound healing. I also use it to great effect for skin irritations with my animals. Particularly those conditions that cause horses and dogs to rub and subsequently loose hair.