Formulated Therapeutic Products of Animal Fats and Oils: Future Prospects of Zootherapy

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ABSTRACT
In the traditional system of practices, animal fats and its oil gained acceptance in healing various ailments. Fats are chemically triglycerides in which glycerol is esterified with three fatty acids. The fats are generally obtained from animal by rendering methods. The main difference between fat and oil is that they are solid and liquid at room temperature respectively. Fatty acid composition present in oil is determined by GC-MS analysis. And it mainly includes oleic acid, palmitic acid, stearic acid, linoleic acid and linolenic acid. This composition plays an important role in antimicrobial, anti-inflammatory, antibacterial activities. The therapeutic products from the animal’s fat and oils are presenting the tremendous acceptability for human, while used by various route of administrations for various internal and external therapeutic indications. This merit of the animal’s fat and oils make it an exceptional choice for using them as a drug. The key fatty acid present in the oil are mainly responsible for the therapeutic activity. The different types of fat obtained from varieties of animal include crocodile, turtle, lizard, sheep, cobra, shark, python etc. Lack of scientific evidence for the traditional healing practice using animal fats or its oils make researches to scientifically prove the therapeutic activity and this may lead to the new era for the development of a variety of novel formulations. Animal based products are also gained importance along with animal based medicines. This article focuses on various animal fats, its traditional uses and some of the formulations developed recently by using these.

Key words: Zootherapy, Animal Fat, Animal Oil, Animal Product, Formulated Animal Products.

INTRODUCTION
Fats are mainly produced from plant, marine and animal sources. Fats obtained from animals can be used both for food and medical applications and these fats are produced mainly through rendering method which has been developed and practiced over since last 200 years. There are literatures having the details of use of animals and animal products for healing purposes from pre-historic times. In this process slaughtered animals by products are converted into useful marketable products including food, agricultural, medicine and industrial use. Animal fat stands as a natural versatile basis for many products and more than 25 million tons of animal fats are produced worldwide. Different categories of animal fats are available; include, tallow, lard, fish oil and butter. All of these can be utilized in various therapeutic and non-therapeutic applications. 40% of Bovine animals are utilized for meat and meat products and in case of porcine animals 62% are utilized. Fats are also obtained from small birds like chickens and turkeys to big birds like ostrich. Lard obtained by rendering adipose tissues of pig is rich in mono unsaturated fatty acids (MUFA), that is, oleic acid and also some amount of polyunsaturated fatty acid (PUFA) linoleic acid. Animal fats are chemically triglycerides in which glycerol is esterified with three fatty acids and made up of long chain fatty acid or saturated fatty acids. These saturated fatty acids have high melting point and are thermally stable. Animal fats are either solid or liquid at room temperature. If the product obtained is liquid, it is classified as oil. Examples are emu oil and lard oil. Lipids can be divided into four categories: simple, compound, derived and terpenoids. Simple lipids are defined as esters of fatty acids with alcohols, particularly glycerol and cholesterol. These can be divided into three classes: triglycerides, steroids and waxes. Triglycerides, in which glycerol is esterified with three fatty acid. Steroids are lipids that cannot be saponified, which means that they cannot be hydrolyzed by heating in the presence of alkalis and soap is not produced from their fatty acids. The most abundant steroids are sterols among which cholesterol is the main sterol of animal tissues. Waxes are defined as esters of fatty acids with long chain alcohols and constitute the natural protecting coverage of leaves, stems, insects, skin, feathers and hairs and also, they act as the structural material of beehives. They possess no nutritional value because they are hydrophobic in nature and cannot be degraded by the digestive enzymes of superior animals. They are further divided into phospholipids, glycolipids and lipoproteins. The article offers limited information about an animal product which has a reputation in therapeutics from ancient era i.e., the fat and oil and the possible formulations attempted by the researchers and presented to the scientific world for further studies. These products are establishing a respectful and trustworthy platform for the zootherapy in the era of modern therapeutics. Zootherapy refers to the use of the animal products in the healing processes against various human diseases.

METHODOLOGY
A literature review of the published literature regarding several animal fats, oils, other products and including the therapeutic importance of animal medicines was performed. A descriptive analysis regarding these animal fats or oils was made. A search was conducted using the popular Internet based scientific data bases such as Science direct, PubMed, Springer, Elsevier etc. as well as in other sources such as research paper based journals and scientific books.
that were available. The keywords used were animal based products, animal fats, animal oils, zootherapy etc.

A particular consistency was followed: Defining the study question: What are the various animal fats and oils used therapeutically and the future prospects of zootherapy? The key words "animal based medicines" AND "animal fats" OR "animal oils" AND "zootherapy" etc. were given as input in the databases PubMed, NCBI, Springer etc. Clinical Queries. Other relevant sources of information were also reviewed thoroughly and the suitable papers were selected and finally compiled together to form the review article.

**ANIMAL BASED MEDICINES**

The modern system of practice finds importance in the use of animal fats and oil which leads to the development in the field of medicine. Several therapeutic products can be developed from these fats. Traditionally animals have been used as medicinal resources for various ailments throughout the world. Various folk medicines were derived from animal body parts, from products of its metabolism or from non-animal material. The healing of human ailments by using therapeutic products that are obtained from animals or ultimately are derived from them is known as zootherapy and this is performed by a trained and qualified zootherapist.

Animal products that is being used traditionally includes the blood of the black caiman (Melanochus niger) is used to treat epilepsy and stroke. Ants of the genus Pseudoxyrum are used in toothache or are left to bite painful joints. Fats of the lion (Panthera leo) and hyena (Crocuta crocuta) are used topically to alleviate abdominal pains. Tusks of hippo are used as aphrodisiacs and ornamentals; the fat extracted from manatee (Trichechus senegalensis) is used to cure rheumatism, boils and backache. According to traditional Chinese medicine, earthworm possess antipretic, antispasmodic, diuretic, antihypertensive, anti-allergic, anti-asthmatic, detoxicant and spermatocidal effect as well as alleviation of Rheumatism. In traditional Chinese medicines, great varieties of animal fats are being used for divergent therapeutic purposes, some of which are even related to tissue regeneration. One of the important principles for the ancient healers in China is that they believe food and therapeutic agents coexist. Fats could be obtained both from domestic and wild animals. Domestic animals used include cow and bull, sheep, pig, donkey and the main wild animals used are deer, shark, snake, bear, frog etc.

**THERAPEUTICALLY USED ANIMAL FATS AND OILS**

**Ostrich Oil**

Ostrich (Struthio camelus) is a species of large flightless bird native to hot countries like Thailand and Australia. It belongs to the family Struthionidae. Oil is obtained from its adipose tissue which is rich in triglycerides and essential fatty acids like alpha-linolenic acid and linoleic acid. Due to the presence of these essential fatty acids the oil is well known for its nutritional, cosmetic and pharmaceutical uses. It has a very good free radicle scavenging activity and the capability of oil in defending membranes from oxidative stress is related to its fatty acid composition, Vitamins and amino acids. The presence of antioxidants makes it a healthy food and various other compounds such as carotenoids, tocopherol and flavones show therapeutic benefits. Oil is also having an anti-inflammatory, antibacterial activity and is considered as a good skin protectant.

Oil can be prepared by rendering which is regarded as the most conventional method and this can be done in two ways classical method and developed processing method. In classical processing method, oil obtained by rendering the adipose tissue at high temperature without adherent tissue cleaning and drying step while in developed processing method, tissue was cleaned and dried and rendered at low temperature. The dominant fatty acids present in both the oils obtained include lauric acid, oleic acid, palmitic acid, followed by stearic acid, myristic acid and lauric acid.

**Emu oil**

The anti-inflammatory and antioxidant activity was shown by emu oil which is obtained from emu (Dromaius novaehollandiae) native to Australia. This activity was mainly due to the polyunsaturated fatty acids. The liquid fat of emu can be used topically for various ailments such as wound healing, to alleviate pain and for mucoskeletal disorder. Apart from the medicinal use, it also has nutritional and health benefits. They also have moisturizing and cosmetic properties. Emu meat is low in cholesterol and the different 3 and 6 fatty acids present are α-linolenic acid, linoleic acid, arachidonic and docosahexaenoic acid which serve as a good source of nutrition. The chicken and beef meat contain less amount of polyunsaturated fatty acid than emu meat.

The various activities of emu oil include, it has been used as an alternative therapy for chemotherapy induced mucositis, inflammatory bowel disease such as ulcerative colitis and Crohn’s disease can be treated by emu oil through its ability to enhance repair process. Auricular inflammation has been decreased by emu oil, osteoporosis caused by cancer chemotherapy can be reduced by non-glyceride components of emu oil. The total cholesterol (TC) and low density lipoprotein (LDL) are reduced by emu oil and showed hypcholesterolemia activity. It stimulates skin and hair growth by topical or parenteral administration. Non irritating nature of emu oil provides moisturizing and cosmetic properties along with good penetrating ability. Emu oil can be used as a transdermal vehicle or penetration enhancer. Topically applied emu oil act as an excellent insect repellent. Emu oil was also effective in psoriasis.

**Crocodile oil**

The antimicrobial and anti-inflammatory properties of crocodile obtained from the Nile crocodile (Crocodylus niloticus) was used by traditional practitioners to treat microbial infections and inflammatory conditions. Gas chromatography was performed for determining the fatty acid composition. The major components of oil include oleic acid, palmitic acid and linoleic acid along with sixteen other fatty acids. Activity of the oil against Staphylococcus aureus, klebsiella pneumonia and candida albicans was done by micro plate method. The anti-inflammatory activity of the oil was assessed by oral administration and topical application using a mouse of acute croton oil induced contact dermatitis. The anti-inflammatory assays showed optimal activity at three hours after the administration of oil (60.8%) and at twelve hours after topical application (57.5%). The anti-inflammatory assay showed longer duration of action after topical application when compared with oral administration of oil.

Paleosuchus palpebrosus also known as Cuvier’s smooth fronted Caiman, Dwarf Caiman is the smallest crocodilian species mainly found in the neotropical region and also in the Amazon and Orinoco River. Atlantic coast waste drainage area. The presence of a crest crown on the posterior region of the head is the striking feature of this species. The products obtained from the species is used in the treatment of diseases or conditions like asthma, thrombosis, rheumatism, edema, mycosis, sore throat and as an antidote for snake bite.
Cobra oil
Oil is obtained from the depot fat of *Naja kaouthia*, a cobra oil. Snake oils have been used as traditional remedies in skin care and many diseases and cobra oil was traditionally used in Thailand. It is also used to prevent excessive hair loss, migraine and in treating fractured bone. The obtained depot fat was cut and blended and then it was incubated at 37°C. The oil was extracted through simple methods and fatty acid composition was determined using GC-MS. Unsatuated fatty acids were found to be higher than that of saturated fatty acids that is, 55.16% and 26.29% respectively. The dominant fatty acid present in cobra oil was palmitic acid, followed by vaccenic acid and linoleic acid. Antioxidant activity of cobra oil was detected by DPPH free radical scavenging and found out that the oil could inhibit free radical scavenging. Investigations on cytotoxicity effect of oil on cancer line cells was done by MTT assay for which three cancer cells KATO-3, HepG2 and SW620 were treated with various concentrations for 24, 48 and 72 hr of incubation and declining of cell counts was noticed and showed that some of the fatty acids components in cobra oil was responsible for its activity.

Turtle oil
*Phrynops geoffroanus* is South American Turtle mainly found in lakes, rivers and stream with a carnivorous diet. The oil obtained from the body fat of this animal is used traditionally to treat illness such as sore throat, mumps, rheumatism, arthritis and the oil is also having antimicrobial activity. The specimen is collected and anesthetized using ketamine, sacrificed and their body fat was removed and the oil was extracted with hexane using Soxhlet apparatus. The determination of fatty acid was done by GC-MS and the main components were found to be palmitoleic and oleic acid (58.39% and 15.7% respectively). Anti-inflammatory activity was tested in certain strains of bacteria and the anti-microbial activity was proved. The antimicrobial activity is due to the presence of above unsaturated fatty acid. *Phrynops tuberosus*, commonly called as Peter's side necked turtle generally found in Guyana, the south eastern portion of Venezuela, Suriname, French Guyana, the eastern Amazon basin and in areas of northeastern Brazil. The species is widely used as food and is a popular medicine for treating asthma, sore throat, swelling, earache, rheumatism and arthritis. Indian turtle, *Erthmoechelies imbricata* is mainly found in the Bay of Bengal least coast of Madras state. The fat obtained from its body was refined and freed of phosphatides. Then it was hydrolyzed and the preliminary separation of the mixed fatty acids into groups differing in unsaturation was done by Lead salt-ethanol and Lithium salt-acetone methods. Ester fractionation procedure was used for finding compositions of resulting fractions. The major fatty acids present in it was found to be myristic acid (10%) and 15% of palmitic acid.

Sheep fat
It is obtained from tails of domestic sheep, *Ovis aries* by directly removing the fat content and oil can be prepared using rendering methods. The main fatty acids present in sheep oil includes palmitic acid (28–29 %), stearic acid (13–15 %), myristic acid (3–4%) and other unsaturated fatty acids. On comparison with cow fat sheep fat appears harder and contains more saturated fatty acids. Generally, it is used for soothing “toxicity,” debilitation, diarrhea, constipation and polydipsia. Externally sheep fat is indicated for cracking skin, burns, frostbites and skin infection. It is contraindicated for those suffering from common cold with cough and sputum. The sheep fat is effectively used in treating damage induced knee articular joint with formalin.

Shark fat
The shark oil is taken from the liver s of the sharks, which are heated to give the oil. Shark fat contains a rich supply of squalene, alkyglycerols, Vitamins A and D as well as polyunsaturated fatty acids in low amounts. It is believed that shark oil might have anti-cancer effects since these constituents are modulators of immunity and alkyglycerol s and squalene are responsible for anti-tumor activity via different mechanisms like induction of apoptosis of neoplastic cells, suppression of signal transduction, inhibition of angiogenesis and promoting transmembrane transport of cytotoxic agents. In the past decades, this marine item has been used as an oral agent for the treatment of different types of cancer. Cancers arising from the upper gastrointestinal tract, namely, esophagus and stomach are believed to the able to get the best benefits. They have also been recommended in patients suffering from atop dermatitis.

Python fat
Python fat can be extracted from various wild python species like *Python sebae*, *Python molurus*, *Python tigris* etc. and it is seen to have a golden yellow color which turns to pale yellow on standing. It has proven its effectiveness in the treatment of rheumatism, boils, keloids and broken bones etc. In the case of keloids, which exhibit excessive collagen deposition, python fat has shown to decrease the collagen accumulation possibly with increased collagenase activity. This was demonstrated through in-vitro studies on keloid tissues from patients which were surgically removed and treated with python fat, revealed a successive decrease in me a collagen concentration and dose dependent increase in collagenase activity with increasing amount of python fat. *Python regius*, smallest non-venomous python species found in Africa. The fat obtained from them, had a hypoglycemic potential and the effect was studied by treating alloxan induced diabetic rats with different concentrations of fat for 14 days. There was a decrease in blood glucose levels in the experimental rats after its oral administration concluding its hypo- glycemic effect.

Lizard fat
Indian Spiny- tailed lizard *Saara hardwickii* is a unique herbivorous reptile that belongs to the family Uromastyceidae. The species is found in patches across the arid zones in India, Afghanistan and Pakistan. In India, it is distributed mostly throughout Thar Desert of Rajasthan and Gujarat and it is the only herbivorous lizard in India. Lizards can be identified through natural marks in their body which includes stripes blotches in young, body notches, broken tails and sloughed skin. Oil is mainly obtained from its skin and tail. It is mainly used as an aphrodisiac and also has other medicinal uses.

Peter’s lava lizard (*Tropidurus hispidus*) is a small sized animal belonging to the family Tropiduridae. This species is mainly found in northeastern Caatinga and in the open areas in the northern portion of the Amazon River. It is widely used as a popular medicine to treat alcoholism, dermatomycosis, warts, boils, sore throat and to treat umbilical cord of newborn babies.

FORMULATED ANIMAL OILS AND FATS

Crocodile oil burn ointment
A novel ointment formulation crocodile oil burn ointment (COBO) was developed to provide more efficient burn wound healing activity. It also has significant antinociceptive and anti-inflammatory activity. Crocodile oil was extracted from the fatty tissue of crocodile (*Crocodylus siamensis*) and it was traditionally used for the treatment of various ailments such as sore throat, mumps, rheumatism, arthritis and is the oil is also having yellow color which turns to pale yellow on standing. It has proven its effectiveness in the treatment of rheumatism, boils, keloids and broken bones etc. In the case of keloids, which exhibit excessive collagen deposition, python fat has shown to decrease the collagen accumulation possibly with increased collagenase activity. This was demonstrated through in-vitro studies on keloid tissues from patients which were surgically removed and treated with python fat, revealed a successive decrease in me a collagen concentration and dose dependent increase in collagenase activity with increasing amount of python fat. *Python regius*, smallest non-venomous python species found in Africa. The fat obtained from them, had a hypoglycemic potential and the effect was studied by treating alloxan induced diabetic rats with different concentrations of fat for 14 days. There was a decrease in blood glucose levels in the experimental rats after its oral administration concluding its hypo- glycemic effect.
as skin rashes and to promote wound healing. Mainly the practice of healing was observed in traditional Chinese and south east medicine. The fatty acid present in oil was palmitic acid, oleic acid and linoleic acid. The experiment was carried out by developing an ointment and burn wound was carried out in Wistar albino rats by inducing a deep secondary burn wound. It was then observed for burn wound, healing and anti-inflammatory activity. The results showed that the COBO would enhance the burn wound healing as well as accelerates skin regeneration and growth of hair follicles. It also has an analgesic and anti-inflammatory activity.16

Lipid emulsion containing fish oil
Intravenous lipid emulsion (ILE) containing fish oil has been approved to use in US. It's lower triglyceride concentration, inflammatory markers and liver function enzymes and improves morbidity and mortality outcomes in critically ill surgical patients. In earlier studies showed that soya bean oil was used instead of fish oil which causes mortality in surgically ill patients. So, an alternative fish oil intravenous lipid emulsion (FOILE) was developed and could improve patient care for surgical patients. FOILE has found to be safer, improved the outcomes and it was an alternative standard of care.17

Ostrich oil based nano emulsion
The oil was obtained from fats of Struthio camelus belonging to the family Struthionidae, having anti-inflammatory activity. Different fatty acids such as linoleic acid, palmitic acid, linolenic acid, oleic acid was present in the oil. Oleic acid present in it helps in penetration of the oil deeply into the tissues. Nano emulsions are coloidal particulate system, transparent clear and thermally stable emulsion of oil, surfactant and co surfactant with size of globules 100 nm. The experiment was carried out by developing a formulation of nano emulsion using ostrich oil.13 The prepared nano emulsion was assessed for various physiochemical parameters. In vitro inflammatory studies were carried out in male Wistar rats by carrageenan induced paw edema. The results showed that novel preparation accelerated the anti-inflammatory activity.14

Emu oil based Nano Emulgel
Emu oil was derived from the emu bird (Dromaius novaehollandiae) and it showed anti-inflammatory, analgesic, anesthetic, antioxidant activity. Most of fatty acids in emu oil are unsaturated and the major one is oleic acid. Curcumin is a yellow colored phenolic pigment along with other curcuminoinds like dimethoxy curcumin, bisdemethoxy curcumin curcumin in the rhizomes of Curcuma longa (Zingiberaceae). Curcumin shows a spectrum of activities like anti-inflammatory, antihyperlipidemic, anticancer, antiinflammatory, antimicrobial, antiapoptotic activities. The experiment involves the preparation of curcumin loaded Nano emulsion by dissolving curcumin in emu oil and then incorporated into Carbopol gel for the convenient application by topical route. The emu oil based curcumin nanogels for transdermal delivery of curcumin was a suitable approach to bypass the first pass metabolism. Thus, its synergistic activity accelerated the anti-inflammatory, antioxidant and analgesic activity in joint synovium and ameliorates arthritis.16

CONCLUSION
Traditionally animals have been used as a medicinal resource for the treatment of various ailments. The fats obtained from the animals were used for therapeutic purposes. The different therapeutic activity of animal oils was mainly due to the unsaturated fatty acids. Knowing about the therapeutic uses of animal fats helps in the development of different formulations. Bird’s oils like oil obtained from ostrich are having anti-inflammatory activity and are used in ulcerative colitis, mucositis and psoriasis. Crocodile oil is traditionally used to treat microbial infection and inflammatory conditions, used topically in contact dermatitis. The depot fat obtained from the cobra oil is having cytotoxic and are traditional remedies in skin care. Sheep fat is indicated for cracking skin, burns, frostbites and skin infections. Squalene present in shark oil is responsible for anti-tumor activity. The oil is also recommended in patient suffering from atopic dermatitis. Python fat oil is effectively used in the treatment of rheumatism, boils, keloids and broken bones etc. Spiny tailed lizards; a unique herbivorous reptile found mainly in the arid zones of India is used as an aphrodisiac. Peter’s lava lizard is widely used as a popular medicine to treat alcoholism wart, boils, sore throat and to treat umbilical cord of new born babies. Several other animal oils are also used as medicines. Obtained from Balbus balus (buffalo wax), Ancer ancer (goose), Camellia japonica (camel), Sus scrofa (hog), Vulpes sp.(fox), Capra hircus (goat), Equus caballus (horse wax), Moschus moschiferus (musk deer), Ovis (lamb), Spalax leucodon ehrenbergi (mole), worm, fish etc.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest.

ABBREVIATIONS
MUFA: Mono unsaturated fatty acids; PUFA: Polyyn-saturated fatty acid; TC: Total cholesterol; LDL: Low density lipoprotein; GC: Gas chromatography; DPPH: 2,2-Diphenyl-1-picrylhydrazyl; COBO: Crocodile oil burn ointment; ILE: Intravenous lipid emulsion; FOILE: Fish oil intravenous lipid emulsion.

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