Emu Oil Processing and Properties

E. Hernandez, Ph.D. Food Protein Research & Development Center, Texas A&M University

INTRODUCTION

Production of emu meat and oil has been steadily increasing in recent years, and both products are starting to be studied in more depth. Some data has already been published on the properties of the oil; however, there are still some discrepancies on some of its measured characteristics. Some of these discrepancies are due to differences in methods of measurement and the source of the oils.

There are no established methods to process the emu oil in particular; however, the technology to recover and refine this oil is readily available. This paper will comment on some of the properties of the oil that have been published in literature and also will include some of the methods commonly practiced in the industry to extract and refine emu oil.

PROCESSING

Due to the nature of emu oil, rendering and refining practices of this oil have to take into account the fact that this oil is more susceptible to spoilage than the usual rendered animal fats such as lard or tallow. Modern technology and equipment to render animal fats are readily available and can be easily adapted to processing emu oil Extraction and refining of emu oil have to be carried out under moderate conditions of temperature and minimal exposure to air. This makes it necessary to study different processing parameters such as temperature and the use of nitrogen to provide an inert atmosphere.

Extraction of Emu Oil - There is not a single method to render emu fat. This industry is relatively young; therefore, manufacturers are using rendering methods that they consider best for their needs. However, some generalizations can be made as to the process of rendering. Figure 1 outlines some of the operations involved in rendering.

1) Washing. Removal of fatty tissue from the emu carcass is relatively easy and usually no special equipment is necessary to separate the fat from the muscle tissue. However, it is particularly important that the fatty tissue be clean and devoid of dirt and contaminants such as blood, feathers, or manure. Once the fatty tissue is removed from the carcass, the washing step can be carried out manually, or in larger operations, with the use of washing sprays and conveyor belts. In conventional operation the water used is 120° - 140° F.

2) Cooking. In this operation the fat is removed from the fatty tissue by breaking the fat cells through application of heat. This softens the tissue and allows the fat to break free. Here temperature and exposure to air are critical. It is recommended that, regardless of the cooking method, the cooker be blanketed with nitrogen to prevent oxidation from the presence of air. Two methods are generally used in this operation, namely wet rendering and dry rendering. In wet rendering, the fatty tissue is charged into a closed or open tank and boiling water is added. The hot water helps break the fat cells and the liquid fat comes to the surface where it is separated and then washed with a weak acid solution.

In dry rendering, the fatty tissue is heated in a jacketed closed vessel. The fat cells are ruptured by dehydration and the fat is released as the moisture evaporates. Cooking operation under vacuum is reported to reduce cooking time and spoilage of the final product. This operation is conducted at 180° - 250° F. In the case of emu oil, it is up to the manufacturer to choose the processing temperature, taking into account that the higher the temperature the higher the yield in oil, but also the lower the quality of the final product due to overexposure to heat.

3) Fat Separation. Fat generated in the cooker is then filtered to further eliminate contaminants and this is done in several ways. A simple way is to allow solids to settle and then separate the fat fraction by decanting. This method is time consuming and not very effect for larger operations. Other ways to separate solids from the fat released in the cooker is hydraulic press, screw press and centrifuging. The chosen method will depend on the nature of the recovered fat and the size of the operation.

4) Fat Washing. This operation is carried out to coagulate and separate proteinaceous components of the recovered fat and can be done by simple water washing, steam coagulation, phosphate (trisodium phosphate) washing, citric acid washing or a combination of these methods. This operation will depend on the amount of uncoagulated protein in the fat and is usually done at temperatures below 210° F. Coagulated material usually settles rapidly, and its removal is done in settling tanks. Washed fat is then filtered to remove any remaining suspended particles before going into the dryer. This is usually done in a filter press with the use of a filter aid such as diatomaceous earth, which is added to facilitate passage through the filter cloth. Another way to separate suspended solids in the washed fat is the use of disk-type, self-cleaning centrifuges. Centrifuges are more expensive and are usually used in larger operations.

5) Fat Drying. Water present in the fat, particularly in the presence of air, will cause the fat to deteriorate rapidly. Therefore, it is important that the oil be dried immediately after the washing step.

Moisture removal is usually done by flash drying. The washed fat is first rapidly heated (up to 240° F) and then pumped into a tank where the water flashes out from the fat. The vapor thus generated is condensed and collected in a different tank. This operation can be done at a lower temperature if vacuum is used.

Refining of Emu Oil. The oil generated in the extraction operation may be high in free fatty acids, peroxides, and other impurities and also may have unpleasant odors. This makes it necessary to further process the oil to make it fit for use as an edible product or for use in cosmetics or pharmaceuticals. The presence of metals in rendered fats in general is unavoidable due to contact of the fat with blood tissue. Metals are very effective catalysts in the generation of free fatty acids from triglycerides and rapidly generates rancidity in crude or finished oil

Free fatty acids formed further deteriorate into peroxides which themselves decompose into odorous materials which give the oil from the rendering operation an unpleasant smell. Decomposition of proteinaceous materials, particularly if the bacterial count is high, also generates obnoxious smells. This makes is necessary to follow some or all of the following refining treatments in order to bring the oil to the desired specifications of a final product (see Fig. 2). To what extent the oils should be refined will depend on its initial quality and on its final use, i.e., cosmetics, pharmaceuticals, or food.

1) Caustic neutralization. This operation is carried out to remove free fatty acids from the original fat and are not harmful per se. However, they are precursors of peroxides and carboxylic compounds that are responsible for unwanted odors and rancidity in fats, and their removal is usually the first step in the refining process. This is usually done by neutralizing the free fatty acids with a weak caustic solution (10-15%) and adding a slight excess to ensure complete neutralization. The neutralized free fatty acids are then easily removed by centrifugation as saponified matter. This step also removes residual matter such as phosphorous-based gums commonly found in crude oils and any uncoagulated protein that may have remained in the oil from the rendering operation.

After the oil has been neutralized and centrifuged, it is usually washed with deionized water to remove residual saponified matter, and the excess water that remains in the oil is then removed in a flash dryer.

2) Bleaching. This operation is usually practiced to remove unwanted colored compounds in oils. Examples of these color compounds are carotenoids, chlorophyll, and burnt or polymerized matter.

An acid-activated clay is usually used for the removal of these colored compounds. However, bleaching also serves as a "cleaning" step of other contaminants.

The acid-activated clay, in conjunction with other adsorbents normally used for bleaching, also serves as a catalyst to decompose or remove peroxides and metals that may still be present in the oil. In the case of emu oil, the bleaching operation is seldom used to remove color. Emu oil extracted under moderate temperature and minimal exposure to air usually has an acceptable color. However, the oil may still have some metals and an excess of peroxides and saponified matter that must be removed from the oil. The adsorbents used in bleaching effectively remove these contaminants. It is extremely important that most metals be removed before processing the oil any further. The next step is usually deodorizing, and if any metals are present in the oil during deodorizing, it may in fact worsen the quality of the final product.

3)Deodorizing. This operation is performed to remove odors, peroxides, and carboxyl compounds from the bleached oil. In some cases, this step is used to remove free fatty acids as well. If the starting oil is good quality, the neutralization step with caustic solution may be avoided, and the deodorizer can be used also as a physical refiner.

Deodorizing is usually done by injecting pure steam into the heated oil (350 - 450° F) under high vacuum (2-4mmHG). The resulting oil from this step is also usually devoid of peroxides and short chain carboxyl compounds. Table l lists some typical characteristics of deodorized oil with regard to free fatty acids, color and other specifications typically measured to assess the quality of a finished oil. Usually, this is the last step in processing an oil At the end of the deodorizing step, an antioxidant is added to the final product such as BHT or tocopherols which will retard spoilage and allow a longer shelf life. Metal scavengers such as citric acid (0.01%) are also added during the cooling period of the deodorization process.

4) Winterization. After several days in storage, emu oil will develop two layers: a bottom layer of high-melting stearins and an upper layer of lower-melting, more unsaturated oleins. The properties of these two layers have not been studied in depth, but in the case of oils such as cottonseed or sunflower, the development of a stearin fraction is considered unsightly. If the oils are intended as salad oils, they are chilled (usually at 40° F), and the stearin formed is removed by filtration. The resulting oil is now devoid of turbidity and is what is called a clarified salad oil In the case of emu oil, this operation can also be performed if the objective is to produce a clear product.

The oil resulting from the chilling process will have a slightly different fatty acid profile. If the final objective is to preserve the same fatty acid composition but also an oil that will not separate into two phases, a process of randomization can be conducted.

5) Randomization. Separation of a solid and clear phase in edible oils can be prevented by randomization. Since this separation is due to a difference in composition of the stearin (richer in saturates) and olein (richer in unsaturates), rearranging the distribution of the fatty acids in the triglyceride molecules would make the overall distribution of fatty acids more uniform and therefore no phase separation occurs. Randomization does not change the overall fatty acid composition of the oil. This operation is carried out with the aid of a catalyst such as Na ethoxide and is usually done at mild temperatures (70 - 90° F). This operation is commonly practiced in processing other rendered fats such as lards and tallow.

PROPERTIES OF EMU OIL

The general physical properties of emu oil are similar to those of a vegetable oil with intermediate content of saturated fatty acids. Table 2 compares the composition of emu oil with other commonly found oils. With regard to fatty acid composition, emu oil is similar in oleic acid content to oils such as peanut or canola oils. With regard to saturated fatty acids, emu oil resembles cottonseed oil. However, no data is yet available on the distribution of the fatty acids in the triglyceride. This triglyceride distribution in emu oil can play a major role in some of its properties such as melting point, solid fat content and formation of the stearin phase. In-depth research in this area is warranted.

Table 1 lists some physical properties of emu oil. The reported information varies somewhat depending on the country of origin and source of the oil. It is likely that the type of feed given to the animal will have some influence on some of the properties of the oil. In general, however, this oil has a higher content of unsaturated fatty acids than typical animal fats (See Table 2). Some reports show contents of oleic acid above 45-55%, linoleic 15-20%, trace amounts of palmitoleic and linolenic acids. The main saturated components are palmitic (20-25%) and stearic acids (8-12%).

Table 1.

Some Properties of Emu Oil	
Iodine value	75 - 80
Free Fatty acids	0.05 %
Refractive Index	1.46 (~ 20°C)
Peroxide Value	0
Specific gravity	0.92 g/ml
Anisidine	0

The ultimate quality of the refined emu oil will depend strongly on the starting material. It should be noted that once an oil begins to spoil, regardless of how well the oil is refined, the final product will reflect this problem as having an excess of hydrolyzed glycerides. For example, if the crude oil has blood tissue producing a high content of free fatty acids, even though the refining process will eliminate the acidity of the oil, the final product will contain high concentration of mono- and di-glycerides which easily degrade during storage.

The quality of a processed oil is usually evaluated by the following factors:

1) Free fatty acids (%)
2) Peroxide value
3) Anisidine value
4) Color
5) Flavor
6) Metals (FE, Ca, Mg, P)
7) Water Content
8) Gas chromatographic analysis

Gas chromatographic analyses are useful not only to determine if there is an unusual amount of mono- and di-glycerides, but also if there are any contaminants in the oil.

As mentioned above, free fatty acids are precursors for peroxides and carboxylic compounds such as aldehydes and ketones that are the ones that give the rancid smell to the oil. A combination of factors accelerate the spoilage of an oil such as the presence of metals, water, and high storage temperatures.

The following are typical specs of a final product that will have a good shelf life:

Free fatty acids <0.05%
Anisidine value => 0
Phosphorous =>0
Peroxide value<1 meq/Kg
Fat stability test=PV <25 (8hr)
FE=>0

Table 2. Comparison of Dietary Fats*

Oils	**Percentage of Fat**			
	% Sat.	Mono-Unsat.	Linoleic	Linolenic
Canola	6	58	26	10
Safflower	9	13	78	

Sunflower	11	20	69	
Corn	13	25	61	1
Olive	14	77	8	1
Soybean	15	24	54	7
Peanut	18	48	34	
Cottonseed	27	19	54	
Emu Oil**	28	53	17	2
Lard	41	47	11	1
Palm	51	39	10	
Beef Tallow	52	44	3	1
Butterfat	66	30	2	2
Coconut	92	6	2	

*USDA Agricultural Handbook No 8-4 **Average of several reported values.