EFFECTS OF RAW CANDLENUT (*Aleurites moluccana* (L.) Willd.) KERNEL ON MEAT FATTY ACID COMPOSITION IN BROILER CHICKENS

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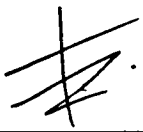

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ABSTRACT

Achieving a better balance of fatty acids in the diet has become the issues in animal nutrition field to decreasing intakes of cholesterol and saturated fats of consumer. The objective of the study was to determine the effects of raw candlenut kernel as feed supplement on meat fatty acid composition in breast and thigh part of broiler chickens. A total of 100 DOC male broiler chicks (Cobb500) were bought and assigned into treatments randomly using Completely Randomized Design (CRD). There are four treatments which are basal diet containing no supplement as control treatment (T1), basal diet supplemented with 2.5% of candlenut (T2), basal diet supplemented with 2.5% candlenut oil (T3) and basal diet supplemented with 2.5% candlenut waste (T4). These treatments were given starting from 22 days old. Data obtained has been analysed based on one way ANOVA using the generalized linear model of SAS. 20 broiler chickens were slaughtered at the age of 42 days old and meat sample has been taken of breast and thigh part. Proximate composition of meat was analysed for their dry matter, moisture, ash, crude protein and crude fat content. Only dry matter and crude fat shows significant difference among treatment where T3 (88.74%) and T2 (12.95%) was the highest respectively. Proximate analysis for broiler finisher diet was analysed to help in giving the information for the transferring of composition from diet to the meat. Raw candlenut kernel does not affect the compositions of meat for their dry matter, moisture and ash content. It does affect broiler meat crude protein where T3 (23.16%) was the highest. Crude fat in T3 also the highest with 36.61%. Fatty acid composition for breast part and thigh part, the ratio of n-6/n-3 was not affected by treatment given even though n-6 content in breast part shows significant for T3 (25.40%). Which means that the raw candlenut kernel does not affect the fatty acid composition of meat of broiler chicken. In conclusion, raw candlenut kernel does not give any significant effects as feed supplement on meat fatty acid composition in breast and thigh part of broiler chickens. Adequate ratio of n-6/n-3 contributes to maintaining and even improvement of health for consumer. As a recommendation, study on which materials are naturally rich in PUFA thus their effect on the health of consumers should be done more.

KESAN ISIRUNG BUAH KERAS (*Aleurites moluccana* (L.) Willd.) MENTAH TERHADAP KOMPOSISI ASID LEMAK DALAM DAGING PADA AYAM PEDAGING

ABSTRAK

Tujuan kajian ini adalah untuk mengenalpasti kesan isirung buah keras mentah sebagai makanan tambahan terhadap komposisi asid lemak daging pada ayam pedaging. Sejumlah 100 ayam pedaging (Cobb500) DOC telah dibeli dan dibahagikan kepada rawatan secara rawak menggunakan reka bentuk rawak sepenuhnya (CRD). Terdapat empat jenis rawatan iaitu makanan asas yang tidak mengandungi campuran tambahan sebagai kawalan (T1), makanan asas yang mengandungi 2.5% isirung buah keras (T2), makanan asas yang mengandungi 2.5% minyak isirung buah keras (T3) dan makanan asas mengandungi hampas isirung buah keras (T4). Kesemua rawatan ini akan diberikan bermula ketika ayam berumur 22 hari. Jumlah pengambilan makanan dan peningkatan berat badan ayam akan di ambil setiap minggu. Data yang didapati telah di analisis menggunakan ANOVA sekata menggunakan model SAS. 20 ekor ayam telah disembelih dan sampel daging ayam telah diambil daripada bahagian dada dan paha ayam pedaging. Komposisi proksimat yang telah di analisa adalah seperti jisim kering, kelembapan, abu, protein kasar dan lemak kasar daging ayam. Hanya jisim kering dan lemak kasar menunjukkan perbezaan yang beerti diantara rawatan di mana T3 (88.74%) dan T2 (12.95%) adalah yang tertinggi bagi setiap satu. Analisis proksimat bagi formulasi makanan ayam dilakukan bagi membantu dalam mengenal pasti kadar komposisi yang terkesan pada daging ayam daripada formulasi makanan. Isirung buah keras mentah tidak memberi kesan terhadap komposisi daging bagi jisim kering, kelembapan dan abu. Ianya hanya memberi kesan terhadap kandungan protein kasar dimana T3 (23.16%). Kandungan lemak kasar di dalam T3 juga adalah yang tertinggi dengan nilai 36.61%. Kandungan asid lemak untuk bahagian dada dan paha, nisbah n-6/n-3 tidak terkesan dengan rawatan yang diberikan walaupun kandungan n-6 bagi bahagian dada menunjukkan perbezaan yang beerti bagi T3 (25.40%). Ini bermaksud isirung buah keras tidak berkesan sebagai makanan tambahan terhadap komposisi bahagian dada dan paha ayam pedaging. Kadar nisbah bagi n-6/n-3 diperlukan kerana menyumbang kepada pengekalan dan kesihatan yang lebih baik. Sebagai cadangan, sebarang bahan yang mempunyai PUFA yang tinggi dan kesannya terhadap kesihatan pengguna perlu lebih dilakukan.

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%E	Percent of energy
AA	Arachidonic acid
AI	Adequate intake
ALA	Alpha-linolenic acid
AMDR	Acceptable macronutrient distribution range
ANOVA	Analysis of variance
ARA	Arachidonic acid
CHD	Coronary heart disease
CRD	Completely randomize design
CVD	Cardiovascular disease
DHA	Docosahexaenoic acid
DMRT	Duncan's multiple range test
DOC	Day old chick
EAR	Estimated average requirement
EFA	Essential fatty acid
EPA	Eicosapentaenoic acid
FA	Fatty acid
FAME	Fatty acid methyl ester
GC	Gas chromatography
HDL	High density lipoprotein
LA	Linoleic acid
LCPUFA	Long-chain polyunsaturated fatty acid
LDL	Low density lipoprotein
ME	Metabolize energy
MUFA	Monounsaturated fatty acid
PUFA	Polyunsaturated fatty acid
SFA	Saturated fatty acid
UFA	Unsaturated fatty acid
USA	United States of America

CHAPTER 1

INTRODUCTION

1.1 Introduction

Animal nutrition is one of the fields that has been highly studied in producing nutritive food products and producing animals. One of the main product of animal is meat and known as source of fat and saturated fatty acids (SFAs) for consumer, where actually they are the main cause for diseases that associated with modern life especially in developed countries. Diseases involved usually cause human mortality or malfunction of body such as Alzheimer's disease, heart disease, diabetes, asthma and cancers (Simopoulos, 2004).

It has been proven that there are many factors affecting the quality of meat. It is well recognized that the quality and chemical composition of produced meat are highly affected by the feed composition (Jubbarah and Elzubeir, 2006). The value of meat is measured in terms of their major chemical components such as proteins, fats, minerals and fatty acids contents (Pearson and Gillet, 1996). Animal fed with specially formulated feeds which are rich in essential requirements, their growth was controlled and the meat production are monitored and controllable using feed formulation. Feed formulation involves the judicious use of feed ingredients to supply in adequate amounts and proportions the nutrients required for the animal.

Meanwhile, there is increasing interest in essential fatty acids (EFAs) for human nutrition and health, also the potential to increase their content in human diets through feed animal formulation with EFA that become the major interest in animal nutrition (Palmquist, 2009). Essential fatty acids are fatty acids that the body of human and animal

requires but cannot synthesis them unless be consumed from the diets. The term "essential fatty acid" refers to fatty acids required for biological processes and not those that only act as fuel (Robert, 1980).

World-wide health professionals are emphasizing the need to increase levels intake of functional or essential fatty acids which are polyunsaturated fatty acid (PUFA), such as linoleic acid (LA), an omega-6 (n-6) fatty acid and alpha-linolenic acid (ALA), an omega-3 (n-3) fatty acid in the diet (Ponnampalam *et al.,* 2006). It actually helps in reducing trans-fatty acids, saturated fatty acids and cholesterol, also it has roles in the prevention and treatment of coronary heart disease, major depression, aging and Crohn's disease, ulcerative colitis and lupus erythematosus (Vos and Cunnane, 2003). Other than that, they can improve the functions of immune, nervous, and cardiovascular systems in humans and the reproductive performance and carcass quality in animals (Robert, 1980).

As because of that, the goals are to identify which materials are naturally rich in PUFA for feed formulation and to determine the true impact of the formulations used and thus their effect on the health of consumers. The polyunsaturated fatty acid (PUFA), although has been said as the key to normal growth and reproduction, it is never in the history been a topic for animal nutrition. Therefore, a detail study on PUFA should be conducted on increase the use of PUFA in animal based food products from their feed.

It has been observed an increasing supplementation of feed with lipids from oil seeds for intensive poultry production. These elements contain predominantly n-6 PUFAs and consequently, poultry lipids have comprised higher levels of such fatty acids and lower levels of n-3 PUFAs. Fatty acid can be transferred easily in poultry as these components LA, ALA and other long-chain polyunsaturated fatty acid content can respond quickly to raise dietary concentrations. Thus, any type of fat that included in the feed will influence the composition of broiler body lipids. Abdominal fat is a good indicator of chicken body fats as it is very sensitive in any changes of dietary fatty acid composition.

Most nuts are rich in monounsaturated fat such as oleic acid and palmitic acid. Monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids are known to have a cholesterol lowering effect when consumed in a reasonable amount in the diet. For

example, like walnuts that high in two polyunsaturated fatty acids linoleic acid (n-6) and a-linolenic acid (n-3).

Today, candlenuts have become most noted for use as a thickener in the cuisines of Malaysia, Indonesia and surrounding regions. It can be found in some Asian markets. Candlenut or 'buah keras' (*Aleurites moluccana* (L.) Willd.) grows wild in the rainforests of the lands of Malaysia. The kernel contains for about 33 to 62.40% (Aguilar and Giron, 1966) of a pale yellow, drying oil which has been proved have great values. It is said that 99 kg of candlenut seeds can yield 19.9 kg of oil (Guzman, 1947). As a drying oil, it has been valued by artists and generally for making paint and varnishes, putty, linoleum and soap. Candlenut oil also can be applied on hair and skin (Altschul and Von, 1973). It contains UFAs also the antioxidants vitamin C and E.

1.2 Justification

It has been proved that the dietary intake of unsaturated fatty acids (UFA) actually helps in reducing the chances of cardiovascular disease (CVD) and possibility of some cancers, asthma, diabetes and others. That is why, it is recommended that the ratio of polyunsaturated fatty acids (PUFAs) to SFAs (P/S) consumed should be above 0.4 while the normal P/S ratio of meat is around 0.1 (Wood *et al.*, 2003).

Strategy in reducing the risk of mentioned diseases need to be done effectively and that is by achieving a better balance of fatty acids in the animal feed formulation to decreasing intakes of cholesterol and saturated fats by consumer. Broiler lipids are a good source of essential n-6 fatty acids for humans but generally have high n-6/n-3 fatty acid ratio. Decreasing this ratio could be one desirable aspect in poultry lipids (Wood *et al.*, 2001).

Nuts are rich in omega-3s and omega-6s, which may explain why they have been shown to help protect against diseases. In a 2010 analysis of four studies, researchers found that a weekly serving of nuts lowered the risk of dying of coronary heart disease by an impressive 8.3%. Therefore, this study is aimed to determine the effects of raw candlenut kernel as a feed supplement in term of fatty acid on meat proximate composition and meat fatty acid composition from various part of broiler chicken which are breast (*pectoralis* muscle) and thigh (*iliotibialis* muscle) part.

1.3 Objective

To determine the effects of raw candlenut kernel as feed supplement on meat fatty acid composition in breast and thigh part of broiler chickens.

1.4 Hypothesis

H_0 : There is no significance difference in the effects of raw candlenut kernel as feed supplement on meat fatty acid composition in breast and thigh part of broiler chickens.

H_a : There is significance difference in the effects of raw candlenut kernel as feed supplement on meat fatty acid composition in breast and thigh part of broiler chickens.

CHAPTER 2

LITERATURE REVIEW

2.1 Candlenut (*Aleurites moluccana*)

Figure 2.1 Candlenut (*Aleurites moluccana* (L.) Willd.)
Source: USDA, 2009

Aleurites moluccana (L.) Willd., also known as candlenut is one of the world's great domesticated multipurpose trees (Figure 2.1). The generic name 'Aleurites' comes from a Greek word 'aleuron', meaning 'floury'. It is native to the Indo-Malaysia region and was introduced throughout the Pacific islands in ancient times. In Indonesia, it has long been grown for both which are subsistence and commercial purposes, sustaining people's everyday lives, especially in the eastern part of the country. This species can be used for various purposes where the seeds can provide material for lighting, cooking and pharmaceuticals while the trunk is used for timber.

It usually grows wild in the rainforests of the land of Malaysia but not in the mainland of Asia and is mainly cultivated in the tropics. It is a most used herb in Indonesia and Malaysia. It also has some medicinal properties that people often use.

2.1.1 Taxonomy

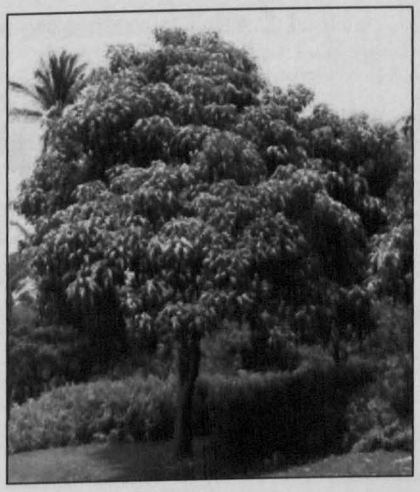

Figure 2.2 Candlenut tree
Source: USDA, 2009

Candlenut (*Aleurites moluccana* (L.) Willd.) is a flowering tree in the spurge family belonging to the Euphorbiaceae family and from subfamily Crotonoideae (Figure 2.2). It also known as candleberry, Indian walnut, kemiri, varnish tree, nuez de la India, buah keras or kukui nut tree. According to USDA (2009), candlenut have synonyms such as *Aleurites javanica Gand.*, *Aleurites remyi Sherff*, *Aleurites triloba Forster*, *Camirium moluccanum* (L.) Ktze., *Croton moluccanus* L. and *Jatropha moluccana* L.

2.1.2 Nutritional facts

In candlenut, it has been reported that it containing anti-nutritive factors such as saponin, falvonoida and polyphenol. Many researchers have proved that these components have implications for health. The content of micronutrients contained in candlenut for example such as proteins, fats and carbohydrates. Potassium, phosphorus, magnesium, and calcium are the dominant mineral in candlenut. It also contains iron, zinc, copper and selenium in small amounts.

There are two types of protein in candlenut nut which are the essential and non-essential amino acids. One function of the amino acid is an amino acid for growth as found in all tissues and form proteins and antibodies. Non-essential amino acids that prominent in the candlenut are the glutamic acid and aspartic acid. The presence of glutamic acid gives a sense of pleasure in the tongue, so the candlenut, could be an alternative substitute flavouring dishes such as MSG. The nutritional benefits present in per 100 g of candlenuts are presented in Table 2.1.

Table 2.1 Nutritional content in per 100 g of candlenut

Energy (kJ)	1,979.0 kJ
Energy (cal)	473.0 cal
Water Content	24.4 mL
Fats	49.9 g
Proteins	7.8 g
Carbohydrates	0.0 g
Complex Carbohydrates	0.0 g
Potassium	876.0 mg
Sodium	14.0 mg
Phosphorus	1,060.0 mg
Calcium	140.0 mg
Magnesium	410.0 mg
Zinc	2.7 mg
Iron	2.7 mg
Copper	6.9 mg
Cadnium	0.1 ug
Thiamine (B1)	4.2 mg
Niacin (B3) Eq.	1.3 mg

Source: Anonymous, 2010

Approximately 53% of the candlenut is fat content. These fat are unsaturated fats which able to reduce the levels of low density lipoprotein (LDL) and prevent blood clot which leads to heart attacks and strokes. Candlenut other essential nutrients are vitamins, folate and phytosterols that can damage forming enzyme of cholesterol in the liver, thus inhibiting the formation of cholesterol.

2.1.3 Candlenut oil

Candlenut kernel has high oil content in about 55-65% (Jamieson and Mckinney, 1937). The oil of candlenut usually extracted from its kernel by using a mechanical extraction method. This method involves a series of processes such as peeling of kernels, screw press, separation and filtration which is time and energy consuming. There is a new method for extracting the oil which is by using super critical fluid extraction (SFE). According to Nik Norulaini *et al.* (2004), this method produces a higher quality and purity oil. It also requires low operating temperature and cost.

Figure 2.3 Candlenut oil
Source: USDA, 2009

The candlenut oil colour is pale yellow (Figure 2.3). It mostly contained unsaturated fatty acid (UFA) and small amount of saturated fatty acid (SFA). Candlenut oil also consist of 86.61% UFA and only 8.39% SFA (Jamieson and Mckinney, 1937). Other study by Eckey (1955) stated that it consists of 97% UFA and 2.8% SFA.

Table 2.2 Fatty acid composition of candlenut oil

Fatty acid	Composition (%)	
	a	**b**
Palmitic acid	4.38	5.5
Stearic acid	3.93	6.50
Arachidic acid	0.08	-
Oleic acid	26.23	10.5
Linoleic acid	39.62	48.5
Linolenic acid	20.76	28.5

Source: a = Jamieson and Mckinney (1937), b = Eckey (1955)

2.1.4 Uses of candlenut

The traditional uses of *A. moluccana* are wide. Almost all parts of the tree, including the leaves, fruits, bark, wood, roots, sap and flowers are useful for traditional medicine, lighting, building materials, dyes, food, decorations and many other uses (Heyne, 1987).

The various parts of the candlenut trees are useful for their medicinal properties. The oil is usually used as a laxative as well as consumed in combination with castor oil because of its purgatory and irritant properties. In Malaysia, the pulped kernels and boiled leaves are often used to cure fevers, headaches, swollen joints, flu, ulcers and gonorrhea. The tree bark is used for treating dysentery or diarrhea in Java. In Hawaii, the flowers and the tree sap is used to cure oral candidiasis in children. The oil is also used to lower cholesterol, reduce body weight and cure arthritis. The oil is also a strong hair stimulant and use in hair care. The plant extracts also have strong antibacterial properties. The pounded seeds are burned with charcoal and applied in the navel area for relieving constipation.

2.2 Poultry feed formulation

Feed formulation is the process of quantifying the amounts of feed ingredients that need to be combined to form a single uniform mixture (diet) for poultry that supplies all of their nutrient requirements. Feed formulation requires thorough understanding of the nutrient requirements of the class of poultry whether they are produced for their eggs, meat or for breeding. Also important to understand feed ingredients in terms of nutrient composition and constraints in terms of nutrition and processing (Eder *et al.*, 2005).

Poultry diets are composed primarily a mixture of several feedstuffs such as cereal grains, soybean meal, animal by-product meals, fats, vitamin and mineral premixes. These feedstuffs, together with water, provide the energy and nutrients that are essential for the bird's growth, reproduction and health, namely proteins and amino acids, carbohydrates, fats, minerals, and vitamins. The energy necessary for maintaining the bird's general metabolism and for producing meat and eggs is provided

by the energy-yielding dietary components, primarily carbohydrates and fats, but also protein (Eder *et al.,* 2005).

2.3 Poultry meat quality

Meat is defined as "all parts of an animal that are intended for or have been judged as safe and suitable for human consumption". Meat is composed of water, protein and amino acids, minerals, fats and fatty acids, vitamins and other bioactive component, and small quantities of carbohydrates (FAO, 2015)

From the nutritional point of view, meat importance is derived from its high quality protein, containing all essential amino acids and it is highly bio available minerals and vitamins. Meat is rich in Vitamin B12 and iron which are not readily available in vegetarian diets (FAO, 2015). Table 2.3 shows the nutritional composition of broiler meat per 100 g.

Table 2.3 Nutritional composition of broiler meat per 100 g

Moisture (%)	75.0
Protein (%)	22.8
Fat (%)	0.9
Ash (%)	1.2
Energy (kJ)	439

Source: FAO, 2015

2.4 Fatty acid

Fatty acid is an important component of lipids as it is a fat-soluble components of living cells in plants, animals and microorganisms. Generally, a fatty acid consists of a straight chain of an even number of carbon atoms, with hydrogen atoms along the length of the chain and at one end of the chain and a carboxyl group (−COOH) at the other end. It is that carboxyl group that makes it an acid (carboxylic acid). If the carbon-to-carbon bonds are all single, the acid is saturated and if any of the bonds is double or triple, the acid is unsaturated and more reactive. A few fatty acids have

branched chains while others contain ring structures (e.g., prostaglandins). Fatty acids are not found in a free state in nature as they commonly exist in combination with glycerol (an alcohol) in the form of triglyceride (IUPAC, 2007). Figure 2.4 shows the classification of fatty acid.

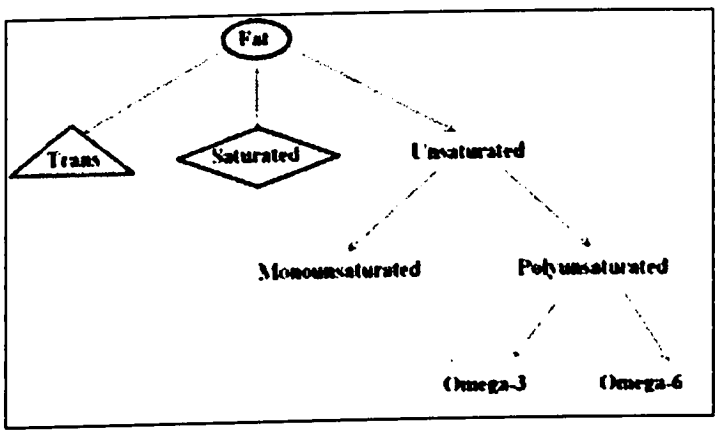

Figure 2.4 Fatty acid/fat classification
Source: IUPAC, 2007

2.4.1 Saturated fatty acid

Saturated fatty acids are 'filled' (saturated) with hydrogen. Most saturated fatty acids are straight hydrocarbon chains with an even number of carbon atoms. The chain-length range is from 2 to 80 but commonly from 12 up to 24. With a chain length from 2 to 6, they are called short-chain, from 8 to 10 they are called medium-chain, and 12 up to 24 called long-chain fatty acids (Beermann *et al.*, 2003). Fatty acids are structurally simple and even with their derivatives can be subdivided into well-defined families.

Among all straight-chain fatty acids, saturated fatty acids are the simplest one (Cifuentes and Alejandro, 2013). They have no unsaturated linkages in the carbon backbone and cannot be altered when hydrogenation or halogenation process. Saturated fatty acids are most commonly found in animals. The most common saturated fatty acids are lauric acid, palmitic acid and stearic acid (Voet, 2006).

In case of individual saturated fatty acids (SFAs), it has different effects on the concentration of plasma lipoprotein cholesterol fractions. For example, lauric (C12:0), myristic (C14:0) and palmitic (C16:0) acids increase LDL cholesterol whereas stearic

(C18:0) has no effect. There is convincing evidence that replacing SFA (C12:0-C16:0) with polyunsaturated fatty acids (PUFAs) decreases LDL cholesterol concentration and the total/HDL cholesterol ratio. A similar but lesser effect is achieved by replacing these SFA with monounsaturated fatty acids (MUFAs). Based on coronary heart disease (CHD) morbidity and mortality data from epidemiological studies and controlled clinical trials that using CHD events and death, it was also agreed that there is convincing evidence that replacing SFA with PUFA decreases the risk of CHD. There also more evidence showing that this SFA gives affect in major disease. Therefore, it is recommended that SFA should be replaced with PUFA (n-3 and n-6) in the diet and the total intake of SFA not exceeds 10%E (FAO, 2010).

2.4.2 Unsaturated fatty acid

It is monounsaturated if only one double bond is present and polyunsaturated if they have two or more double bonds generally separated by a single methylene group in the carbon backbone. The bent structure is common for unsaturated fatty acids. Pairs of carbon atoms connected by double bonds can be saturated by adding hydrogen atoms to them, converting the double bonds to single bonds. Most commonly, unsaturated fatty acids are from vegetable origin. The most common unsaturated fatty acids are oleic acid, linoleic acid (LA), α-linolenic acid (ALA) and arachidonic acid (Voet *et al.*, 2006).

The unsaturated fatty acids are also further classified into three sub-groups according their chain lengths. Short-chain unsaturated fatty acid is fatty acids with nineteen (19) or fewer carbon atoms. Long-chain unsaturated fatty acid is fatty acids with twenty (20) to twenty-four (24) carbon atoms. Very-long-chain unsaturated fatty acid is fatty acids with twenty-five (25) or more carbon atoms.

In polyunsaturated fatty acids (PUFAs) the first double bond may be found whether the third and the forth carbon atom from the omega carbon. These are called omega-3 (n-3) fatty acids. If the first double bond is between the sixth and seventh carbon atom, then they are called omega-6 (n-6) fatty acids. PUFAs which are produced only by plants and phytoplankton are essential to all higher organism including mammals and fish.

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