

## A Review on Coconut oil : An Essential Oil for All

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### Review Article

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#### ABSTRACT

Coconut oil is produced by crushing copra, the dried kernel, which contains about 60-65% of the oil. The oil has the natural sweet taste of coconut and contains 92% of saturated fatty acids (in the form of triglycerides), most of them (about 70%) are lower chain saturated fatty acids known as medium chain fatty acids (MCFAs). MCFAs are not common to different vegetable oils with lauric acid at 45-56%. Various fractions of coconut oil have medium chain triglycerides and are excellent solvent for flavours, essences, emulsifiers etc. These fatty acids are used in the preparation of emulsifiers, as drugs and also in cosmetics. Its metabolism is different from that of the normal vegetable oils containing long chain fatty acids. Hence, it cannot be generalized as oil similar in properties to that of a 92% long chain saturated fatty acids containing oil/fat. More studies are required to prove the good effects of coconut oil, medium chain triglycerides (MCT) and the fatty acids on humans especially on the ill effects on cardiovascular and other diseases. Coconut oil is edible oil obtained from the kernel of harvested mature coconuts of the coconut palm. In recent years this oil has attained superstardom in the health food world. Celebrities are adopting its use, nutritionists advocating it, and patients acclaiming its many virtues. A number of health benefits have been attributed to this oil. These include benefits in skin care, hair care, stress relief, weight loss and cholesterol level maintenance, immunomodulatory effects, cardiovascular uses, and more recently in Alzheimer's disease. However for several years, coconut oil was demonized and consumers were made to believe that coconut oil is deleterious to health as it would block the arteries and cause heart disease. The tide has turned and in recent time's recognition of the positive health effects of coconut oils have emerged stronger. The use of coconut oil, especially virgin coconut oil is in vogue, though some people still remain skeptical. This article attempts to review the coconut oil, its chemical compositions, and its therapeutic uses.

### INTRODUCTION

Lipids are fat-like naturally occurring substances; insoluble in water but, soluble in non-aqueous solvents such as Chloroform, hydrocarbons or alcohols. Lipids can be oils or fat depending on the degree of unsaturation of the fatty acid components at room temperature. Lipids can serve as food when calories demand by the body exceeds calories supply [1]. Coconut (*Cocos nucifera*) belongs to the araceae family. It is a commercial crop in many tropical countries that plays An integral part in diets and livelihoods [2]. Coconuts and the oil content are believed to be rich in various constituent By traditionalists [3]. Kernel derived from coconut fruit is a rich source of oil. Coconut oil is largely consumed for Domestic and industrial purposes which include

cooking, bakery, confectionary, pharmaceutical and cosmetics [4]. Coconut oil has a natural sweet taste and contains 92% of saturated fatty acids (in the form of triglycerides); most of them (about 70%) medium chain fatty acids (MCFAs) [5]. They are also resistant to peroxidation and have been reported to protect against heart disease as they lower the risk of atherosclerosis [6]. Gopala et al [5] have also highlighted the antiviral, antibacterial, antiplaque, antiprotozoal, healing, anti-inflammatory and anti-obesity effects of medium chain fatty acids. Coconut oil may be largely classified as refined (solvent extracted coconut oil) or unrefined medium chain fatty acids. Coconut oil may be largely classified as refined (solvent extracted coconut oil) or unrefined (virgin coconut oil; hot pressed and cold pressed or copra coconut oil) according to their method of preparation [5]. Cold pressed as well as hot pressed coconut oils are extracted from the fresh wet coconut meat. However, while cold pressed coconut oil is prepared from crushed meat at room temperature, the latter is prepared by introducing a little heat as much as 40 °C. This enables the extractor get more oil from the coconut meat compared to the earlier mentioned. Thus, this study was designed to investigate the physicochemical properties, antioxidant activity and phyto-nutritional composition of cold pressed (CP) and hot pressed (HP) coconut oils in a bid to spot out any difference based on their mode of preparation.

### Introductory Profile

#### Biological Source:

Coconut oil, or copra oil, is an edible oil extracted from the kernel or meat of mature coconuts harvested from the coconut palm (*Cocos nucifera*). It has various applications. Because of its high saturated fat content, it is slow to oxidize and, thus, resistant to rancidification, lasting up to six months at 24 °C (75 °F) without spoiling.(7)

**Family:** Arecaceae

**Habitat :** The coconut tree (*Cocos nucifera*) is a member of the palm tree family (Arecaceae) and the only living species of the genus *Cocos*. [7,8] The term “coconut” (or the archaic “cocoanut”) can refer to the whole coconut palm, the seed, or the fruit, which botanically is a drupe, not a nut. The name comes from the old Portuguese and Spanish word *coco*, meaning ‘head’ or ‘skull’ after the three indentations on the coconut shell that resemble facial features. They are ubiquitous in coastal tropical regions, and are a cultural icon of the tropics [9].

#### Etymology

The name coconut is derived from the 16th-century Portuguese and Spanish word *coco*, meaning ‘head’ or ‘skull’ after the three indentations on the coconut shell that resemble facial features. [10,11,12] *Coco* and coconut apparently came from 1521 encounters by Portuguese and Spanish explorers with Pacific islanders, with the coconut shell reminding them of a ghost or witch in Portuguese folklore called *coco* (also *côca*). [13,14] In the West it was originally called *nux indica*, a name used by Marco Polo in 1280 while in Sumatra. He took the term from the Arabs, who called it *جوز الهند* *jawz hindī*, translating to ‘Indian nut’. [15] *Thenga*, its Malayalam name, was used in the detailed description of coconut found in *Itinerario* by Ludovico di Varthema published in 1510 and also in the later *Hortus Indicus Malabaricus*. [16] The specific name *nucifera* is Latin for ‘nut-bearing’.

**Kingdom:** Plantae

**Order:** Arecales

**Family:** Arecaceae

**Subfamily:** Arecoideae

**Tribe:** Cocoseae

**Genus:** *Cocos* L.

**Species:** *C. nucifera*

**Binomial name:** *Cocos nucifera* L.

#### Botanical Description:

##### Plant

Trees are typical single-trunked palms, reaching up to 100 ft in height, but generally 20-50 ft in cultivation. Leaves are among the largest of any plant (up to 20 ft), pinnately compound with 200 or more leaflets, and borne in a spiral arrangement at the apex of the trunk. Leaf life span may be 3 years, and mature, healthy palms have about 30 leaves, forming a new one and dropping the oldest one each month.

##### Flowers

Separate male and female flowers are borne in the same inflorescence, which is a compound spadix arising in the leaf axil. Flowers are off-white to gray or yellow, and inconspicuous. They are generally protandrous, meaning that male flowers release pollen before females become receptive. Flowering occurs continuously, since each leaf axil produces one inflorescence, and new leaves are produced approximately monthly.

##### Pollination

Since coconuts are protandrous, they are believed to be largely cross pollinated. Dwarf cultivars, particularly the popular ornamentals, are largely self-pollinating as opposed to the Tall cultivars of commerce which rarely pollinate themselves.

### **Fruit**

Coconuts are large, dry drupes, ovoid in shape, up to 15" long and 12" wide. The exocarp or skin is green, yellow, or bronze-gold, turning to brown, depending on cultivar and maturity. The mesocarp is fibrous and dry at maturity; the product coir is derived from this layer. The endocarp is the hard shell enclosing the seed. Seeds are the largest of any plant, and have a thin brown seed coat. Seeds are filled with endosperm, which is solid and adherent to the seed coat, and also in liquid form, called "milk". Copra is derived from the solid endosperm [17].

### **Chemical properties**

Coconut oil contains a high proportion of glycerides of lower chain fatty acids. The oil is highly stable towards Atmospheric oxidation. The oil is characterized by a low iodine value high saponification value, high Saturated fatty acids content and is a Liquid at room temperature of 27 °C.

### **Unsaponifiable matter**

All natural fats contain minor quantities of substance other than Fatty acid glycerides. The unsaponified constituent is mostly sterols. The unsaponifiable constituent of coconut oil includes a small amount of tocopherols and phyosterols.

### **Chemistry of fatty acids and Triglycerides:**

#### **Medium chain triglycerides**

Medium chain fatty oils (MCTs) are a class of lipids in which three soaked fats are bound to a Glycerol spine. What recognizes MCTs from different fatty substances is the Fact that each fat particle is somewhere in the range of Six and twelve carbons long [18]. MCTs are a part of numerous nourishments, with coconut and palm oils being the Dietary sources with the most noteworthy Concentration of MCTs. MCTs are likewise Available as a dietary enhancement [19]. MCTs have an alternate example of Absorption and use than long chain fatty substances (LCTs) that make Up 97 percent of dietary fats. For Absorption of LCTs to happen, the unsaturated fat chains must be isolated from The glycerol spine by the lipase Enzyme. These unsaturated fats structure Micelles, are then consumed and Reattached to glycerol, and the Resultant fatty oils travel through The lymphatics on the way to the Bloodstream. Up to 30 percent of MCTs are assimilated flawless over the Intestinal boundary and straightforwardly enter The entrance vein. This takes into consideration a lot Quicker assimilation and usage of MCTs contrasted with LCTs. MCTs are Transported into the mitochondria Independent of the carnitine transport, Which is vital for LCT mitochondrial assimilation. Oxidation Of MCTs gives 8.3 calories per Gram, while LCTs gives 9.2 Calories per gram [20].

#### **Coconut Oil as a source of Medium-chain triglycerides**

All fats and oils are made out of Triglyceride particles, which are tri esters of glycerol and unsaturated fats. The fats upon hydrolysis yield unsaturated fats and glycerol. There are two techniques for ordering unsaturated fats, monounsaturated unsaturated fats, and polyunsaturated unsaturated fats. The second technique for arrangement depends on atomic size or length of the carbon chain in the unsaturated fat. The dominant part of the fats and oils whether they are soaked or unsaturated or from a creature or a plant, are made out of long-chain fatty substances. All fats we eat comprise of LCT while, coconut oil is exceptional on the grounds that it is made overwhelmingly out of MCT. The size of the unsaturated fat is critical on the grounds that physiological impacts of medium-chain unsaturated fats in coconut oil are particularly not quite the same as the long-chain unsaturated fats all the more ordinarily found in our eating regimen [21]. It is the MCT in coconut oil that make it not quite the same as every other fat and generally gives it its interesting character and mending properties. Practically the entirety of the medium-chain fatty oils utilized in exploration, medication, and food items come from coconut oil. MCT are effortlessly processed, consumed, and put to utilize sustaining the body. In contrast to different fats, they put little strain on the stomach related framework and give a fast wellspring of energy important to advance mending. This is significant for patients who are utilizing each ounce of solidarity they need to beat genuine sickness or injury. It's no big surprise why MCT are added to baby recipes. MCT are found in coconut oil as well as are characteristic and essential segments of human bosom milk. MCT are viewed as fundamental supplements for new born children just as for individuals with genuine stomach related issues like cystic fibrosis [22,23]. Like other basic supplements, one must get them legitimately from the eating regimen.

### **Uses**

#### **Antioxidant and Antistress Activity**

An examination completed by Yeap SK et al assessed the antistress and cell reinforcement impacts of virgin coconut Oil in vivo. VCO decreased lipid peroxidation and increment the movement of SOD in the serum of mice undergoing the constrained swim test and the cerebrums of mice exposed to ongoing cold restraint<sup>10</sup>. VCO has been accounted for to be rich in polyphenols and these add to the expanded cancer prevention agent chemical levels, Which thus lessens aggravation and lipid peroxidation in VCO-treated mice. Rebuilding of cerebrum antioxidant levels ruins further neuronal harm consequently forestalling ensuing monoamine depletion<sup>11</sup>. The capability of VCO to forestall work out and ongoing cold limitation stress-initiated harm and to re-establish the cancer prevention agent balance was exhibited and this was ascribed to the polyphenols and medium-chain

unsaturated fats present in VCO. In another investigation on the similar impact of VCO with copra Oil, olive oil and sunflower oil on endogenous cell reinforcement status and paraoxonase-1 action in ameliorating the oxidative pressure in rodents, discoveries uncovered that dietary VCO improved the cancer prevention agent status when contrasted with the other three oil-taken care of gatherings, as was clear from expanded catalase, superoxide dismutase, glutathione peroxidase and glutathione reductase exercises in tissues [24].

### **Hepatoprotective activity**

A few examinations have announced the cancer prevention agent action of VCO (Virgin Coconut Oil). Oxidative pressure prompted by the generated free revolutionaries assumes a lead function in the improvement of hepatic toxicity [25]. An examination was led on hepatoprotective movement of VCO on 2, 4-Dichlorophenoxyacetic corrosive (2, 4-D) prompted liver harm in Rats [26]. Rodents treated with 2, 4-D demonstrated a huge liver harm with expanded serum transaminases and alkaline phosphatase proteins exercises, and hepatic lipid peroxidation and liver free unsaturated fats. Serum complete protein, egg whites, hepatic superoxide dismutase and glutathione peroxidase catalysts exercises were significantly decreased. Aggravation and corruption were seen in liver segments of treated rodents. VCO oil treated creatures indicated an improvement in hepatic cancer prevention agent proteins, serum transaminases exercises And liver free unsaturated fats levels which was affirmed by histopathological assessment, along these lines establishing the hepato defensive action of VCO [27].

### **Anti-inflammatory, analgesic, and antipyretic activities of VCO (Virgin Coconut Oil)**

An examination directed by Intahphuak et al, assessed the calming, pain relieving, and antipyretic effects of VCO in rodents utilizing ethyl phenyl propiolate-prompted ear edema and carrageenan and arachidonic acid-initiated paw edema. VCO was found to have moderate mitigating impacts. Through decrease of the transudative weight, granuloma development, and serum antacid phosphatase activity, VCO displayed an inhibitory impact on constant irritation. In acidic corrosive incited squirming, the model for pain relieving movement and for yeast-instigated hyperthermia for antipyretic action, VCO indicated a moderate pain relieving and antipyretic effect [28].

### **Wound Healing Effect**

Wound mending is an unpredictable cycle where the skin or other body tissue fixes itself after injury. The oil of *Cocos nucifera* has been accounted for to be a compelling injury mending agent [29]. Nevin et al considered the effect of effective utilization of virgin coconut oil on skin segments and cancer prevention agent status during dermal injury mending in youthful rodents. In their investigation, creatures were treated for 10 days with VCO, 24 hours after formation of the injury. VCO's recuperating movement was assessed by observing time for complete epithelization notwithstanding different boundaries of the injury's granulation tissue. Dissolvability example of collagen, glycohydrolase action and granulation tissue histopathology were additionally considered. Creatures treated With VCO demonstrated a lot quicker twisted recuperating movement, shown by a diminished time in complete epithelization and more significant levels of different skin parts. The critical increment of pepsin-dissolvable collagen and glycohydrolase exercises noticed demonstrated higher collagen cross-connecting and its turnover [30].

### **Use as an Ocular Rewetting Agent**

Dry eye is an indication brought about by the absence of value/amount of tears or deformity on the visual surface zone. That drives a state of distress, visual unsettling influence; tear film precariousness, expanded osmolality of The tear film and irritation of the visual surface, which enhance the harm to the visual surface. Among all the helpful choice for dry eyes, fake tears is the backbone for the underlying administration of dry eye understanding. Because of the multifaceted nature of tear film, it is hard to produce tears that would be like that of the natural eye. A few brands of counterfeit tears are economically accessible, that would comprise of hydroxypropyl methyl cellulose, poly vinyl liquor, sodium hyaluronate and oil based tears. VCO was discovered to be protected in the dry eye and its mitigating property was credited to be liable for its huge valuable impact in the administration of dry eyes [31].

### **Immunomodulatory effect**

In 1966, Jon Kabara discovered that medium Chain Fatty Acids (MCFA's) of virgin coconut oil are Incredible for antimicrobial properties that kill harmful viruses, bacteria, fungi, and parasites. When MCFA's are digested, they break down into free fatty acids and monoglycerides [32]. Lauric Acid, Capric Acid, and Caprylic acid are the important medium chain fatty acids present in coconut oil that possess antimicrobial activity. Their monoglyceride form, monolaurin, monocaprylin, and monocaprin hinder Microbes from terrorizing the immune system. Individually, these fatty acids act on microbes in different Ways. Some may kill a particular organism that causes fungal infections but may not be as useful on other microbes. Unitedly, however they act as a highly powerful defence against diseases. Monolaurin (monoglyceride form of lauric acid) is considered to have the best antiviral, antifungal, and antibacterial effect .

### **Effect on blood sugar control**

A study on Insulinotropic potency of lauric acid: a metabolic rationale for medium chain fatty acids (MCFA) in TPN formulation by Garfinkel M et al proved that the effect of MCFA on insulin secretion depends upon its chain length. Among all MCFA capric acid (C10) and lauric acid were observed to display the most potent effects on insulin secretion. Another study proved that, as compared to other oils, coconut oil in the diet enhanced insulin action and improved binding affinity.

### Effect on weight loss

An examination directed on the impact of dietary medium-and long-chain triacylglycerols (MLCT) on accumulation of muscle to fat ratio in sound people by Kasai M et al demonstrated that a day by day admission of MLCT diet could cause a decrease in body weight and muscle to fat ratio aggregation. Volunteers in a twofold visually impaired investigation for 12 weeks, burned-through every day at breakfast, test bread, with 1.7 g MCFA, bread made with long-chain Triacylglycerols (LCT) was devoured by the benchmark group [33]. A critical abatement of body weight and amount of fat, with a huge decline in serum all out cholesterol was seen in the test group. In another investigation on the impact of dietary supplementation with coconut oil on the biochemical and anthropometric profiles of ladies with stomach weight (midriff peripheries (WC) >88 cm) the Intake of dietary enhancement with VCO was seen to diminish the measure of stomach fat.

### Conclusion

Coconut oil has a Long shelf life and is used in baking Industries, processed foods, infant Formulas, pharmaceuticals, cosmetics and as hair oil. The oil contains 92% Of saturates consisting of medium Chain fatty acids in the form of Triglycerides, and about 8% of Unsaturates consisting of oleic and Linoleic acids as triglycerides. The oil has a small amount of unsaponifiable Matter (< 0.5%), is colourless and has an odour typical of the coconuts. The oil has small amounts of Tocopherols and tocotrienols and Phytosterols. The oil is known to have antiviral and antibacterial Effects and excellent healing Properties. Overall it is the best essential oil and has all properties which are essential for human health.

### REFERENCES

1. Olaniyi AP, Babalola OO and Oyediran AM. Physicochemical properties of palm kernel oil. Res. J. Biol. Sci. 2014;6(5);205-207.
2. Kappally S, Shirwaikar A and Shirwaikar A. Coconut oil – a review of potential applications. Hygeia J Drug Med. 2015;7(2);34-41.
3. Sani I, Owoade C, Abdulhamid A, Fakai IM and Bello F. Evaluation of physicochemical properties, Phytochemicals and mineral composition of Cocos nucifera L. (Coconut) kernel oil. Int J Adv Res Chem Sci. 2014;1(8);22-30.
4. Kumar PKP, Krishna AGG. Physicochemical characteristics of commercial coconut oils produced in India. Grasas aceites. 2015;66(1);1-15.
5. Krishna AG, Gaurav R, Singh BA, Kumar PP, Preeti C. Coconut oil: chemistry, production and its applications-a review. Indian Coconut J. 2010;53(3):15-27.
6. Conrado SD. Coconut oil: Atherogenic or Not? (What therefore causes Atherosclerosis?). Philipp J Cardiol. 2003;31(3);97-104..
7. J. Pearsall, ed. (1999). "Coconut". Concise Oxford Dictionary (10th ed.). Oxford: Clarendon Press. ISBN 0-19-860287-1.
8. Dalgado, Sebastião (1982). Glossário luso-asiático. 1. P. 291. ISBN 9783871184796. Archived from the original on June 2, 2016.
9. Losada FD. The language platform. Editorial Tecnológica de CR; 2004:978-9977-66;161-162.
10. Figueiredo, Cândido. (1940). Pequeno Dicionário da Língua Portuguesa. Livraria Bertrand. Lisboa. (in Portuguese)
11. Elzebroek, A.T.G. and Koop Wind (Eds.). Guide to Cultivated Plants. CABI. 2008. 186–192 Archived April 21, 2016, at the Wayback Machine. ISBN 978-1-84593-356-2.
12. Grimwood 1975, p. 1 Archived April 21, 2016, at the Wayback Machine.
1. <https://www.jameshaskell.com/coconut-taxonomy>
2. Babayan, V.K. Medium chain Triglycerides. In dietary fat requirements In health and development. (CJ BeareRogers, ed) AOCS press, Champaign, Illinois (USA).1988:73-86.
3. Heydinger JA, NAKHASI DK. Medium chain triacylglycerols. J food lipids. 1996;3(4):251-257.
4. Ralph Hoahland, George Snider G, Digestability of certain higher saturated Fatty acids and triglycerides. J. Nutri., 1943:26(3);219-225.
5. Furman, R.H., Howard R.P., Brusco O.J., Alaupoic P, Effects of Mediumchain length Triglyceride on serumlipids. In medium chain Triglyceride. UPenn Press Pennsylvania 51-61.
6. JohnsonR.C., Cotter R. Metabolism of medium chain triglyceride lipid Emulsions. Nutr. Int., 1986;2;150.
7. Marie-Pierre St-Onge, Robert R, William D. Parsons, Peter J.H. Johns, Medium chain triglycerides increase Energy expenditure and decrease Adiposity in overweight men. Obesity Res., 2003;11(3):395-402.
8. Arunima S, Rajamohan T. Effect of virgin coconut oil enriched diet on the antioxidant status and paraoxonase 1 activity in

- ameliorating the oxidative stress in rats – a comparative study. *Food Funct.* 2013;4(9);1402-1409.
9. Otuechere CA, Madarikan G, Simisola T, Bankole O, Osho A. Virgin coconut oil protects against liver damage in albino rats challenged with the anti-folate combination, trimethoprim-sulfamethoxazole. *J Basic Clin Physiol Pharmacol.* 2014;25(2);249-253.
  10. Hanaa M, Abd EF, Lamiaa A.A. B. Hepatoprotective Effect of Olive and Coconut oils against Oxidative Stress- Induced by 2, 4 Dichlorophenoxyacetic Acid. *Indian J Appl Res.* 2013; 3(12):42-46.
  11. Zakaria ZA, Rofiee MS, Somchit MN, Zuraini A, Sulaiman LK, et al. Hepatoprotective activity of dried- and fermented-processed virgin coconut oil. *Evid Based Compl Alt Med.* 2011: 142739- 142748.
  12. Intahphuak S, Khonsung P, Panthong A. Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil. *Pharm Biol.* 2010; 48(2):151-157.
  13. Srivastava P, Durgaprasad S. Burn wound healing property of *Cocos nucifera*: An appraisal. *Indian J pharmacol.* 2008;40(4):144.
  14. Nevin KG, Rajamohan T. Effect of topical application of virgin coconut oil on skin components and antioxidant status during dermal wound healing in young rats. *Skin Pharmacol Physiol* 2010; 23 (6):290-297.
  15. Haliza A M, Sharanjeet K, Ahmad R G, Ng Chinn H, Nor H S. A Pilot Study: The Efficacy of Virgin Coconut Oil as Ocular Rewetting Agent on Rabbit. *Evid Based Compl Alt Med* 2015; 2015: 135987.
  16. Assuncao ML, Ferreira HS, dos Santos AF, Cabral CR Jr, Florencio TM. Effects of dietary coconut oil on the biochemical and anthropometric profiles of women presenting abdominal obesity. *Lipids.* 2009; 44(7):593-601.
  17. Shilling M, Matt L, Rubin E, Visitacion MP, Haller NA, et al. Antimicrobial effects of virgin coconut oil and its medium-chain fatty acids on *Clostridium difficile*. *J Med Food.* 2013;16(12):1079-1085.
  18. Garfinkel M, Lee S, Opara EC, Akwari OE. Insulinotropic potency of lauric acid: a metabolic rationale for medium chain fatty acids (MCF) in TPN formulation. *J Surg Res.* 1992; 52(4):328-333.
  19. Ginsberg B.H, Jabour J, Spector A.A. Effect of alterations in membrane lipid unsaturation on the properties of the insulin receptor of Ehrlich ascites cells. *Biochim. Biophys. Acta.* 1982; 690(2):15.
  20. Kasai M, Nosaka N, Maki H, Negishi S, Aoyama T, et Al. Effect of dietary medium- and long-chain triacylglycerols (MLCT) on accumulation of body fat in healthy humans. *Asia Pac J Clin Nutr.* 2003; 12(2):151-160.
  21. Assuncao ML, Ferreira HS, dos Santos AF, Cabral CR Jr, Florencio TM. Effects of dietary coconut oil on the biochemical and anthropometric profiles of women presenting abdominal obesity. *Lipids.* 2009; 44(7):593-601.