

**COCONUT FLOUR - A LOW CARBOHYDRATE, GLUTEN FREE FLOUR****A REVIEW ARTICLE****Dr Lalitha Ramaswamy**

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INTRODUCTION

Coconut is the most important versatile crop, which provides all required amenities for human life. The coconut provides a nutritious source of meat, juice, milk, and oil that has fed and nourished populations around the world for generations. On many islands coconut is a staple ingredient in the diet. Nearly one third of the world's population depends on coconut to some degree for their food and their economy. Coconut is rich in fiber, vitamins, and minerals. It is believed as a "functional food" because it provides many health benefits beyond its nutritional content. Coconut is naturally low in digestible carbohydrate, contains no gluten, is cheaper than most other nut flours, is loaded with health promoting fiber and important nutrients, and tastes terrific. Coconut flour is a soft, flour like product made from the pulp of a coconut. It's actually a by-product made during the coconut milk making process. Coconut flour is extremely high in fiber with almost double the amount found in wheat bran. This flour can be used much like wheat flour to make a multitude of delicious breads, pies, cookies, cakes, snacks and desserts. It contains more calorie free fiber than other wheat alternatives. Coconut flour also provides a good source of protein. While coconut flour does not contain gluten (the type of protein found in many grains) it does not lack protein. It contains more protein than enriched flour, cornmeal and also as much as wheat flour. Coconut flour provides many health benefits. It can improve digestion, help regulate blood sugar, protect against diabetes, help prevent heart disease and cancer, and aid in weight loss.

PROCESSING OF COCONUT FLOUR

The manufacturing of coconut flour involves two processing methods

Dry Process

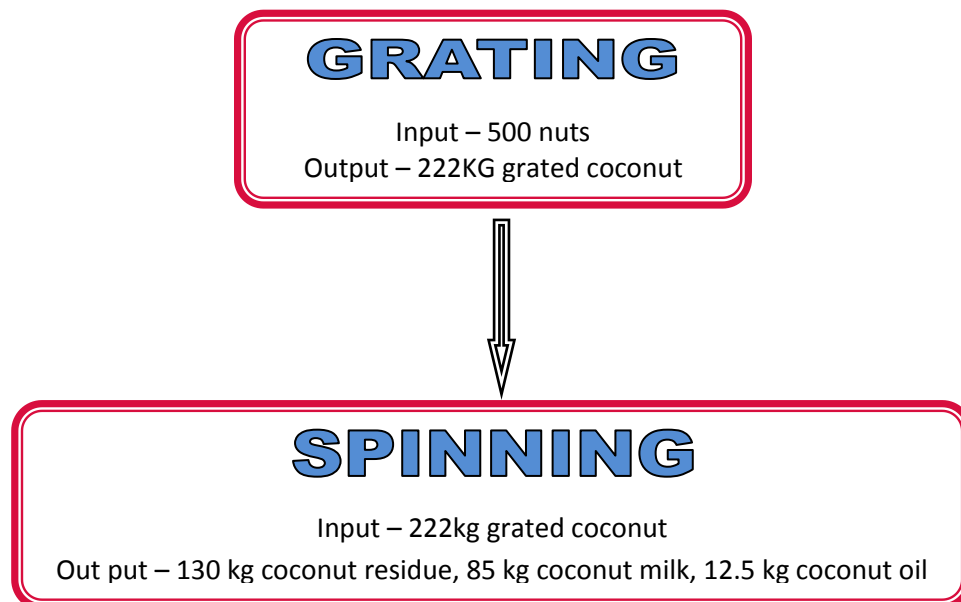
Dry process involves drying of grinded coconut meat, oil extraction and pulverizing the meal. The process produces a high protein coconut flour (33%) which can be used as wheat substitute. The advantages of the this process is the high oil recovery at 88% based on the oil content of the meat. The dry process also produces high protein flour which can be used in the preparation of baked products.

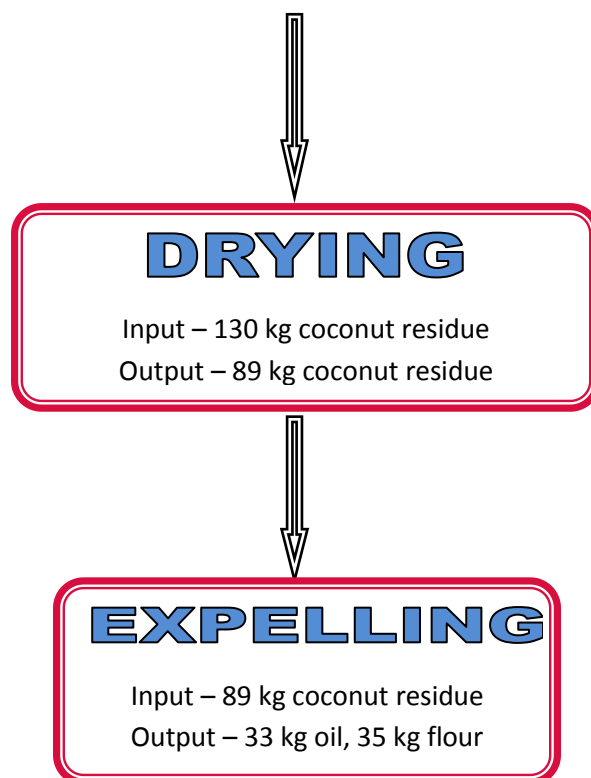
Wet process

In wet process the meat is extracted with milk, drying of the residue and grinding to produce the flour. In the wet process, almost 52% of the available oil in the fresh meat is recovered. To optimize the oil extraction efficiency of the wet process oil is extracted from the meal after milk extraction. Instead of selling the residue as feeds this can be further processed to produce two high-value products, VCO and flour. The coconut flour contains 60% dietary fiber which can be used as a functional ingredient.

Trinidad et al., (2001) states that coconut flour is prepared from coconut residue called “sapal” which is the meal usually discarded after milk extraction. Medium seized coconuts were selected and grated for extraction of milk. Milk was extracted from the grated coconuts by grinding process. The meal remaining, called the sapal was washed in hot water to reduce the oil content. Ragavendra et al., (2004) said that the fat content of the residue left after the extraction was reduced from 62 percent to 45percent by treatment with boiling water. The residue was then sundried for 48hours and then ground. The flour obtained was stored at room temperature and can be used for the preparation of bakery products. The utilization of coconut flour as a functional food will not only solve the problem of chronic diseases now prevailing in almost all countries but also encourage the industry and farmers to produce value-added or healthful products from coconut flour. This will increase the production and promotion of the coconut industry. The process flow and material balance of the production of virgin coconut oil and coconut flour is presented in Figure – I

Figure – I Process flow and material balance of the production of Virgin coconut oil and coconut flour





NUTRIENT COMPOSITION OF COCONUT FLOUR

Composition of coconut flour depends on the retention of components after the extraction of coconut milk or oil from scraped/desiccated coconut. Therefore, composition of coconut residue changes proportionately. The composition of coconut flour produced by two different methods is presented in the table – I

Table - I
Proximate Composition of Coconut Flour

Nutrients	Fresh dry process	Wet dry process
Moisture	4.5	6.7
Fat	10.7	10.9
Crude fiber	40	60.9
Protein	17.5	10.8
Ash	5.5	3.16

Carbohydrat	61.8	68.5
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http://www.pca.da.gov.ph/pdf/techno/flour_vco.pdf

Hagenmaier (1983) reported that coconut flour contains 7.6% protein, 14% oil, approximately 17% crude fibre and 5% moisture. According to Arancon (1999), nutrient composition of coconut flour is mentioned as; protein 13.41%, moisture 2.80%, crude fat 10.23% and crude fibre 19.3%. Trinidad *et.al*, (2006) reported that the dietary fibre content of coconut flour was 60.0 +/- 1.0g/100g sample, 56% insoluble and 4% soluble.

High with Indigestible Fiber

There are two types of carbohydrate in foods: digestible and non-digestible. The type of carbohydrate that is of concern to most people is digestible carbohydrate (starch and sugar). These are the carbs that the body converts into fat and packs into our fat cells. Consumption of excess carbohydrates, contribute to an assortment of health problems such as insulin resistance, obesity, and diabetes. Non-digestible carbohydrate, on the other hand, is composed of fiber and passes through the digestive tract without being broken down or absorbed and is passed out of the body. Instead of contributing to health problems like starch and sugar, fiber promotes good health. Coconut is a natural low-carb, high-fiber food ideally suited for low carbohydrate diets. One cup of shredded fresh coconut (80 grams) contains 3 grams of digestible carbohydrate and 9 grams of fiber. The remaining 68 grams consists primarily of water, fat, and protein. Although a piece of fresh coconut may taste sweet, its digestible carbohydrate content is lower, and its fiber content is higher than most fruits and vegetables. By promptly absorbing and promoting the timely expulsion of irritating agents, carcinogens and even parasites, natural fiber is essential for the systematic cleansing and detoxification of the body.

Rich in Trace Minerals

While most grain products (namely wheat, corn and soy) are mass-harvested on the depleted soils of industrial farms and subject to genetic modification, coconuts offer a refreshing source of naturally occurring trace minerals. Coconut palms are generally found thriving in the mineral rich volcanic soils of the tropics and naturally fertilized with water, which contains a complete mixture of all of the trace minerals required by the human body. Unlike grains, coconuts are also free of phytic acid- a common plant toxin that works as an anti-nutrient.

Low in Digestible Carbohydrates

Refined flours are concentrated in simple carbohydrates which are rapidly metabolized and cause destructive blood sugar fluctuations in the body. In opposition to this, coconut flour has been found in several studies to have a glycemic lowering effect, because coconut meat has a simple carbohydrate content coupled with a high fiber, it yields a flour that is less disruptive to blood sugar levels.

Gluten-Free and Hypoallergenic

Allergies and intolerances to all sorts of products are rampant in this day and age requiring strict protocols results in utmost difficult to follow and also leads to concurrent nutrient deficiencies from the avoided food groups. Naturally bolstering protein, minerals, vitamins and healthy fats of coconut flour, oil and milk offers replenishing source of sustenance for those avoiding specific food groups and struggling to create balanced meals. The organic virgin coconut flour is similar in texture to wheat flour but offers more fiber than wheat bran. It is vegan, low carb flour and gluten free. It is ideal for baked foods. Coconut flour is a good source of protein. It has functional properties as of wheat flour (which has one of the specific protein called “gluten”) but gluten free. This is an advantage for a growing percentage of the population, who has allergic reaction to gluten.

<http://blog.radiantlifecatalog.com/bid/59284/What-are-the-Health-Benefits-of-Coconut-Flour>

PROPERTIES OF COCONUT FLOUR

- Coconut flour has a cream color and is less white than all-purpose flour.
- Slightly nutty odor. It has less coconut flavor (almost bland taste) due to reduced fat content.
- Coconut flour occupy more space per unit volume than banana, all purpose flour, maize, and oat flours.
- Coconut flour has a shelf-life of six months at room temperature, polyethylene plus kraft/chipboard/foil (metallized) and polyethylene alone are suitable packaging materials.

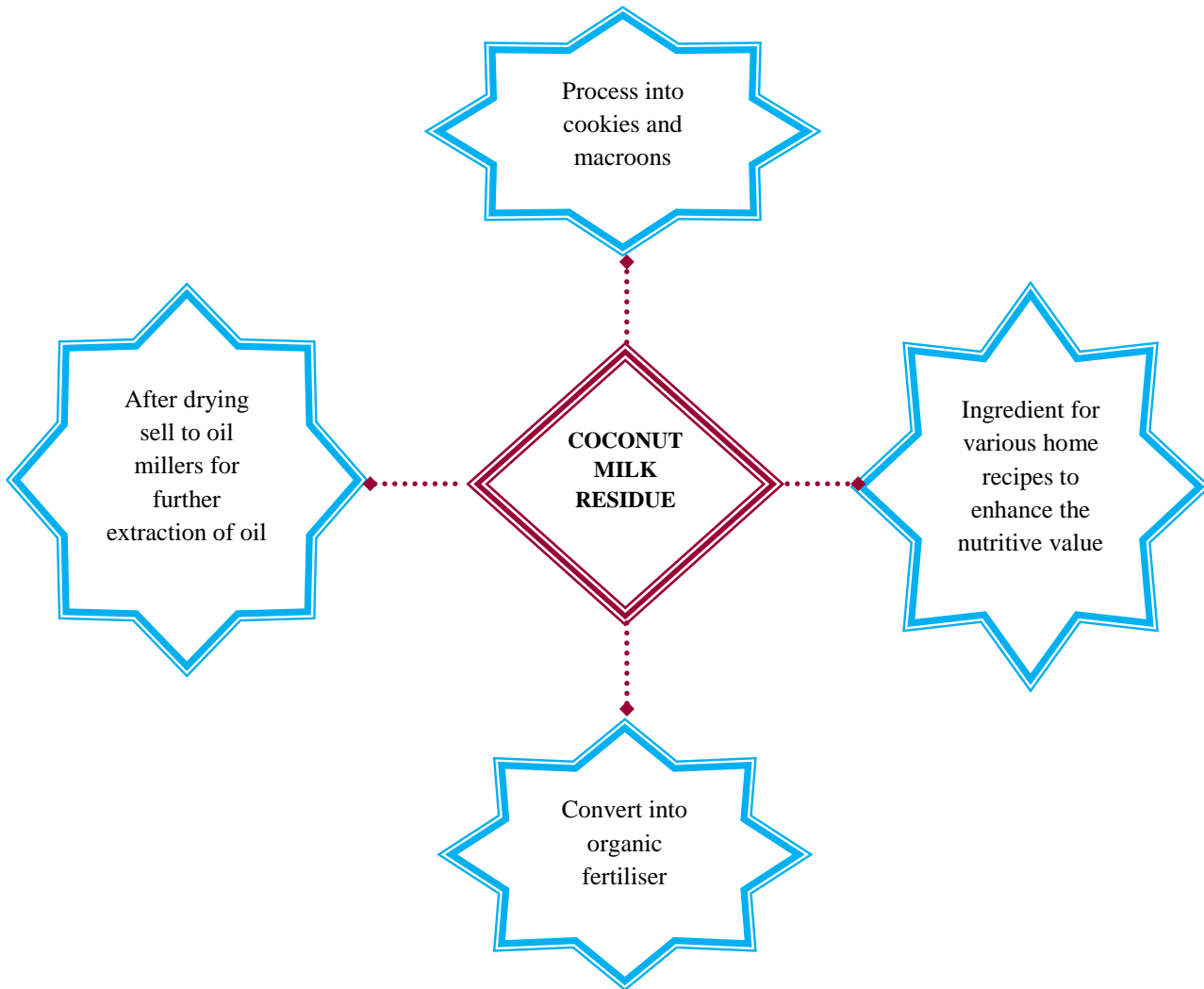
COCONUT FLOUR – FOOD APPLICATION

Coconut milk residue is the solid material left behind when coconut milk is extracted from grated or shredded coconut kernel. It is generated as a by-product of wet processing production (coconut milk route) of VCO. This residue represents approximately 25–50% of the weight of the grated kernel on a wet basis, depending on the coconut milk extraction process that is used. In most Pacific households, the coconut milk residue left after the milk has been extracted is used as animal feed or discarded as waste. The residue has a bland taste, since most

of the protein and fat is extracted with the coconut milk. Dried coconut milk residue, when processed under strict sanitary conditions, can be used as a substitute for desiccated coconut in baked food products such as breads and cookies. Because of its bland taste, it does not detract from other flavours that may be added to cookies to enhance their taste. It can also be used in making fibre-enriched foods and in the formulation of functional foods because of its high dietary fibre content. The various utilization of coconut milk residue is presented in the figure – II

Figure – II

Various utilization of coconut milk residue



(Madhavan et al., 2005) states that the residue obtained during the extraction of milk is dried and used for making sweets, chutney powder and as a thickening agent in curries.

The Food and Nutrition Research Institute of Department of Science and Technology (DOST-FNRI) looked into the potential of using coconut flour as an ingredient in the formulation of functional food such as bread, extruded snacks, processed meat, breakfast cereals and baked goods. As people get more health conscious, the demand for functional food products increases as well. The DOST-FNRI believes that increasing food products with coconut flour is one way to lower the cost of bakery products. FNRI also said that coconut flour has a total dietary fiber (TDF) content that is even greater than the popular dietary fiber sources like oat bran and flaxseed (Mauro, 2013).

Rodgers (2004) has described the necessity of having efficient, environmentally friendly research for the conversion of industrial by-products into functional ingredients, including coconut flour made from coconut residue. It is thus apparent that coconut flour can be incorporated with wheat flour in order to improve the health benefits of bread. Similarly, many studies have been conducted to assess the possibilities of adding natural ingredients to improve the nutritive value of wheat bread (Becker, 1989; Giami et al., 2003 and Klava 2004).

HEALTH BENEFITS OF COCONUT FLOUR

Trinidad *et al* 2001., reported that coconut flour can provide not only value added income to the industry, but also a nutritious and healthy source of dietary fibre. Fife (2005) states that coconut flour is a great source of dietary fiber, free of trans fatty acids and it is low in carbohydrates. It contains 61 percent fiber which is the highest percentage of dietary fiber found in any flour (wheat bran has 27 percent fiber). Coconut flour may play a role in controlling cholesterol and sugar levels in blood and prevention of colon cancer. Studies revealed that consumption of high fiber coconut flour increases fecal bulk (Arancon, 1999)

Dietary fiber has been shown to have important health implications in the prevention for risk of chronic diseases such as cancer, cardiovascular diseases and diabetes mellitus. It comes from the family of carbohydrates, a non-starch polysaccharide, not digested in the small intestine but may be fermented in the colon into short chain fatty acids (SCFA) such as acetate, propionate and butyrate. SCFA contributes 1.5– 2.0 kcal/g dietary fiber (Roberfroid, 1997). It enhances water absorption in the colon, thus prevent constipation. Propionate has been shown to inhibit the activity of the enzyme HMG CoA reductase, the limiting enzyme for

cholesterol synthesis. Dietary fiber has the ability to bind with bile acids and prevents its reabsorption in the liver thus, inhibit cholesterol synthesis (Brussels, 1994). Butyrate enhances cell differentiation thus preventing tumor formation in the colon (Wolever et al., 1992).

Dietary fiber's viscose and fibrous structure can control the release of glucose with time in the blood, thus helping in the proper control and management of diabetes mellitus and obesity (Brussels, 1994). Low glycemic index food e.g. high dietary fiber food, has been shown to reduce post-prandial blood glucose and insulin responses and improve the overall blood glucose and lipid concentrations in normal subjects (Collier et al., 1988), and patients with diabetes mellitus (Fontvieille et al., 1988; Wolever et al., 1992 and Wolever et al., 1994).

Fiber slows down the emptying of the stomach, thus maintaining the feeling of fullness longer than low-fiber foods. As a result, less food and fewer calories are consumed. Studies have shown that consumption of an additional 14 grams of fiber a day is associated with 10 percent decrease in calorie intake and a loss in body weight. The observed changes occur both by consuming high fiber foods, like fresh vegetables or coconut, or from products made with high fiber flours, such as coconut flour.

Coconut fiber has been shown to be very effective in moderating blood sugar and insulin levels. For this reason, coconut is good for diabetes. Diabetics are encouraged to eat foods that have a relatively low glycemic index. The glycemic index is a measure of how foods affect blood sugar levels. The higher the glycemic index, the greater the effect of food raising blood sugar. When coconut is added to foods, including those high in starch and sugar, it lowers the glycemic index of these foods. This was clearly demonstrated by T. P. Trinidad and colleagues in a study published in the British Journal of Nutrition in 2003. In their study, both normal and diabetic subjects were given variety of foods to eat. Some of the types of food included cinnamon bread, granola bars, carrot cake, and brownies, all foods that a diabetic must ordinarily limit because of their high sugar and starch content. It was found that as the coconut content of the foods increased, the blood sugar response between the diabetic and non-diabetic subjects became nearly identical. In other words, coconut moderated the release of sugar into the bloodstream so that there was no spike in blood glucose levels. As the coconut content in the foods decreased, the diabetic subjects blood sugar levels became elevated, as would normally be expected from eating foods high in sugar and white flour. This study showed that adding coconut to foods lowers the glycemic index of the foods and keeps blood sugar levels under control. Sweet foods such as cookies and cakes made using coconut flour do not affect blood sugar levels like those made with wheat flour.

Fiber acts like a broom, sweeping the intestinal contents through the digestive tract. Parasites, toxins, and carcinogens are swept along with the fiber, leading to their timely expulsion from the body. This cleansing action helps to prevent toxins that irritate intestinal tissues and cause cancer from getting lodged in the intestinal tract. Many studies have shown a correlation between high-fiber diets and a low incidence of colon cancer. For example, in one of the most extensive studies to date, involving over 400,000 people from nine European countries, it was found that those who had the highest fiber intake were 40 percent less likely to develop colon cancer. Fiber readily absorbs fluids. It also appears to absorb harmful carcinogens and other toxic substances. Researchers at the University of Lund, Sweden, found that fiber in the diet can absorb toxins that promote cancer. Coconut fiber not only absorbs and sweeps carcinogenic toxins out of the intestinal tract, it also helps prevent the conditions that promote cancer. Evidence suggests that coconut fiber may also prevent the formation of tumors in the colon by moderating the harmful effects of tumor promoting enzymes.

The Food Nutrition Research Institute (FNRI) of the Dept. of Science and Technology (DOST) of the Philippines conducted a study on coconut flour way back in 1999. This study aimed to look at the dietary fiber content (total, soluble and insoluble) of coconut flour and the fermentability characteristics of the dietary fiber simulating conditions in the human colon

According to Dr. Trinidad Trinidad, the results of their study shows the following health and nutritional benefits of Coconut Flour:

- Increasing levels of coconut flour in bakery products resulted in a lower glycemic index especially when it contains 15% to 25% dietary fiber from coconut flour. The reason that coconut flour is well suited for diabetics and others with blood sugar concerns is that it contains mostly non-digestible carbohydrate. Non-digestible carbohydrate is one type of carbohydrate found in food. This type has no calories because of the fiber. Dietary fiber slows down the release of glucose and therefore requires less insulin to utilize the glucose and transport it into the cell where it is converted into energy. Foods rich in soluble dietary fiber are low glycemic index foods.
- Coconut Flour prevents the risk of cardiovascular disease, promotes heart health and supports the immune system. Coconut flour lowers total and LDL cholesterol in the study with 15% to 25% coconut flakes supplemented cereals it helps promote cholesterol health.

- Coconut Flour prevents the risk of colon cancer because the dietary fiber in coconut flour metabolized in the colon is butyrate producing. Butyrate is an important substrate for maintenance of colonic health; it also facilitates better digestion and promotes digestive comfort."

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