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Mango seed kernel, a highly nutritious food, should we continue to trash or use?

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Abstract

World production of mango was about 40 million tons in 2015. India, the largest producer of mango produced about 20 million tons of mangoes in 2016. One hundred grams of mango seed kernel has more nutritional value than 500g of potatoes and 2kg of mango pulp. Mango kernel has 20-fold higher protein, 50-fold higher fat and 4-fold higher carbohydrates than mango pulp. The kernel has nearly balanced quantities of protein, carbohydrates, oils, vitamins, minerals and therapeutic phytochemicals in sufficient quantities. Yet, we eat mango pulp which has only slight nutritional value and we throw away the kernel which has almost 20 – 50 times more nutritional value than the pulp. When we trash the kernel, not only we are polluting our land but we are throwing away a highly nutritious food that is worth hundreds of millions of dollars. The objective of this article is to make people aware of the nutritional values of the mango kernel and promote its utilization.

Keywords: mango, kernel, nutritious food, trash

Introduction

Mango: Mango is a seasonal fruit, produced and harvested essentially in summer. The mango is known as the king of fruits. It is rare to come across someone who does not love mango pulp. We know the importance of mango fruit. However, mango peel and seed are discarded due to the lack of awareness of their nutritional values. Mango nut inside the mango pit/seed is referred herein as kernel. Depending upon the variety of mango, the pit represents 45 to 75 percent of the fruit and about 20 percent of the whole fruit is the kernel.

Objective: The objective of this mini review is to compare nutrient contents of mango kernel with that of mango pulp, potatoes, grains, legumes and other nuts, and make people aware of the nutritional values of mango kernel. Extensive studies been done in mango producing countries on the nutrients of mango pulp, peel and the kernel. A number of research scientists have analyzed and emphasized the nutritional and therapeutic values and uses of the kernel. However, to the best of our knowledge, little efforts have been made to compare nutrients of mango kernel with that of mango pulp and other staple foods, such as potatoes, grains, legumes and nuts, and make people aware of nutritional values of mango kernel.

Articles selected for comparison of nutrients: Certain nutrients are essential for human life and health. The major classes of the nutrients are carbohydrates, proteins, fats, fiber and water as macronutrients (needed in large quantities) and minerals and vitamins as micronutrients (needed in small quantities). A number of studies have been reported on the nutritional values of mango pulp, peel and kernel. It is known to many scientists around the world that the kernel is very rich in protein, carbohydrate, oil, vitamins and minerals. Depending upon the mango variety, cultivation climate, ripening stage, the harvesting time and region/soil, the size of mango and its kernel and their nutritional values vary significantly, some times as much as 50% or higher and there are some inconsistencies and hence it is difficult to average the data or make a systematic comparison. We selected two publications for the comparison which are amongst the most widely referred; (i) M.A Fowomola, African Journal of Food Science, Volume 4, page 472-478, August 2010 for nutrients of kernel and (ii) Ian S.E. Bally, (April 2006) for mango pulp (www.fozli.com/ebook/Mangifera-mango.pdf).

Discussion

Macronutrients: The major components of mango kernel are carbohydrates/starch, fat and protein. The nutrient contents of mango pulp and mango kernel are compared with other staple foods, such as potatoes, grains, legumes and nuts in Table 1.

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Table 1: Comparison of macronutrients of mango kernel with its pulp and with other staple foods

	Average nutrient content of major foods (g/100g)						
	Kernel	Pulp	Potato	Grains	Nuts	Legumes	RDA*
Protein	10	0.5	2	10	25	15	50
Fat	15	0.3	0.1	2	45	6	44
Carbohydrate	70	17	17	75	20	40	130
Fiber	2	1.8	2	7	7.1	16	30

*RDA: Recommended Daily Allowances.

Comparison with pulp: Mango pulp is ~80% water. As can be seen from Table 1, the mango pulp has ~17% carbohydrate, mainly sugar. Only 3% of the pulp has all other nutrients such as proteins, fiber, vitamins and minerals. Mango kernel has ~20 times more protein than that in the pulp⁷. To get 50g protein RDA, one needs to eat 500g of the kernel or 10kg of the pulp. The kernel has 50 times more fat than that in the pulp. To get 44g fat RDA, one needs to eat 300g of the kernel or 15kg of the pulp. The kernel has ~4 times more carbohydrates than that in the pulp. To get 130g carbohydrate RDA, one needs to eat 185g the kernel or 0.75 kg of the pulp. Carbohydrate of the pulp is mainly sugar. Yet, we eat mango pulp which has only slight nutritional value and we throw away the kernel which has almost 20 – 50 times more nutritional value than the pulp!

Comparison with staple foods: The nutritional value of mango kernel is close to that of grains, legumes and nuts. Mango kernel and grains have ~10% protein which is lower than legumes (~15%) and nuts (~25%). The kernel has more fat (~15%) than grains (2%) and legumes (~6%) but lower than nuts (~45%). The kernel and grains have ~70% carbohydrates, which is much higher than nuts (~20%) and legumes (~40%). The kernel has less fiber than grains, nuts and legumes. From nutritional point of view, mango kernel has better balance of macro nutrients.

Comparison with potatoes: The average weight of the kernel in mango is ~20%, 80% is peel, pulp and the shell. Potato has ~80% water⁵. So basically, when we purchase five kilograms of mango and trash a kilogram of mango kernel, we trash food equivalent to five kilograms of potatoes. On solid basis, potato and the kernel have essentially the same percentage of protein and carbohydrate but the kernel has 30 times more fat than that in potato. May be that is why we add oil or butter in potato dishes or fry to get required fat. The macro nutrients of mango kernels are more balanced than that in potatoes.

Amino acids: Proteins are composed of amino acids (AA). Some amino acids (known as essential amino acids) are not

synthesized by human but are essential and hence must be supplied in its diet. The nine amino acids that humans cannot synthesize are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine, and histidine. According to Fowomola¹ and as shown in Table 2, eight essential amino acids (except tryptophan) are present in mango kernel in gram quantities, comparable to that recommended by FAO/WHO. Thus, mango kernel becomes a single source for most amino acids.

Table 2: Amino acid content of mango kernel¹.

Essential AA	g/100g	Non-Essential AA	g/100g
Histidine	2.31	Alanine	6.4
Isoleucine	3.23	Asparagine	NA
Lysine	3.13	Aspartic acid	6.33
Leucine	8.4	Arginine	5.17
Phenylalanine	4.46	Cysteine	2.3
Methionine	1.04	Glutamine	NA
Tryptophan	NA	Glycine	3.5
Threonine	2.04	Glutamic acid	13
Valine	3.8	Serine	2.93
Tyrosine	3.17	Proline	3

Thus, proteins of mango kernel are capable of providing eight essential amino acids, except tryptophan. Typically, legumes lack isoleucine and lysine while grains lack methionine and tryptophan^[10].

Micronutrients: Vitamins and minerals are considered as micronutrients, required in small quantities, such as micrograms to milligrams.

Vitamins: A vitamin is an organic compound and an essential nutrient for normal cell functions, growth and development of humans and other organisms. Vitamins enable the body to break down and use the basic elements of food, proteins, carbohydrates and fats. Most vitamins (except Vitamin D) cannot be made in our body, so they must be acquired from food. There are 13 essential vitamins. This means that these vitamins are required for the body to work properly. They are vitamin A, C, D, E, K, B₁, B₂, B₃, B₅, B₆, B₇, B₉ and B₁₂. As shown in Table 3, mango kernel has antioxidant vitamins, such as vitamin C and E and other essential vitamins such as K, B₁, B₂, B₃, B₅, B₆, B₉ and B₁₂ from 0.1mg to 1mg per 100g and 15 IU of Vitamin A. According to Fowomola¹, mango kernel has 0.12 mg/100g (120 microgram/100g). The daily requirement of vitamin B₁₂ is only 2-3 microgram. If confirmed, the mango kernel becomes the only rich source of vitamin B₁₂. Vitamin B₁₂ deficiency may occur in between 40% to 80% of the vegetarian population.

Table 3: Comparison of vitamin content of mango kernel with other staple foods (in mg/100g except stated and RDA).

Vitamin	Mango kernel	Potato	Grains	Nuts	Legumes	RDA
K (mcg)	0.59		2.3	8.56	4.57	120
E	1.3		1	9.94	3.34	15
C	0.56	11.4	0	0.26	7.88	90
B ₉	NA	NA	NA	0	7	400
B ₆	0.19	0.2	0.4	0.17	0.22	1.3
B ₅	NA	NA	NA	0	0.08	5
B ₃	NA	1.6	7.6	4.57	3.59	16
B ₂	0.03	0.03	0.3	0.3	0.25	1.3
B ₁₂	0.12		0	0	0.04	0.0024
B ₁	0.08	0.12	0.5	0.42	0.24	1.2
A (IU)	15.27		10.8	0	980.02	900

Minerals: Minerals are chemical elements that are involved in various processes in our body. They help to regulate cell function and to serve as building blocks for our cells and organs. Major minerals – those needed in larger amounts – include calcium, phosphorus, magnesium, sodium, potassium and chloride. In addition, our body needs smaller amounts of cobalt, chromium, copper, fluoride, iodine, iron, manganese, molybdenum, selenium and zinc for normal growth and health. The mango kernel contains sodium(21mg), potassium(22mg), calcium(111mg), magnesium(95mg), iron(12mg), zinc(1mg), manganese(0.04mg) and phosphorous(20mg) per100g. Thus, mango kernel is also rich in minerals [7].

Vitamins and mineral contents of mango kernel is comparable to that in grains, legumes and nuts but do not provide required RDA. Typically fruits and vegetables are richer in vitamins and minerals than grains, legumes and nuts.

Phytochemicals & Therapeutics: The therapeutic potential of mango kernel has been extensively investigated for its anti-inflammatory, analgesic, antidiabetic, immune-modulatory, anti-oxidative and anti-carcinogenic activity. Mango kernel powder has been reported to be beneficial in treating diarrhea, reducing blood cholesterol, reducing blood sugar level. The mango kernel contains diverse types of bioactive compounds such as phytosterols, sito-sterols, tocopherols, mangiferin, isomangiferin and polyphenols. Apart from mangiferin, presence of gallic acid derivatives, sesquiterpenoids contribute to very high antioxidant potential to mango kernel⁸. The ellagic acid and its derivatives present in mango kernel have been shown to prevent DNA damage and tumor formations. Compared to most of the nuts and grains, mango kernel has high concentration of phytochemicals and hence much high therapeutic value. Mango kernel is an excellent health and preventive food.

Anti-nutritional factors: Similar to tea, mango kernel also has tannin, which in excess can lead to reduced growth rates and less efficient feed utilization. Tannin has both positive and negative effects on the body. The positive health benefits of tannin come from its anti-carcinogenic and anti-mutagenic properties, mostly due to its anti-oxidizing nature. Tannins also remove harmful microbes from the body, and fight against harmful bacteria, viruses and fungi. By speeding up blood clotting, tannins also have a healing effect on cuts and wounds. Although largely useful to the body, tannin also has negative effects. Tannins is anti-nutritional and can hinder digestion and metabolism. Tannin can also help obstruct the blood's absorption of iron, which may lead to a multitude of health problems. Mango kernel contains Tannin as ~67 g/kg [11]. It can be decreased only by boiling, roasting or autoclaving. Tea contains ~37/kg of tannin. Fortunately, tannin gets destroyed when we cook, e.g., bake, roast or boil the kernel.

Utilization: We don't recommend anyone to consume raw mango kernel. It should be consumed after roasting, baking or boiling. Raw mango kernel is an excellent food but like a raw potato, raw mango kernel does not have appetizing good taste, it has a slightly bitter taste. Roasted or boiled mango kernel is often eaten by many and like any other nuts, roasted mango kernel tastes good as well. Virtually any dish that can made from grains, pulses and nuts can be prepared from the kernel. Like grains, mango kernel has the right percentage of carbohydrates in the form of starch to make virtually any dish.

Flour of dried mango kernel can be utilized as a supplement to that of grains such as wheat, corn and chickpeas. Mango kernel does have sufficient fat/oil and hence, we may not need to add oil or butter to make a dish. Mango kernel is a legume and one make curries like other legumes and vegetables. A number of common dishes can be prepared from mango kernel, starting from breads, snacks, deserts, curries to specialty items such as mango kernel milk (similar to almond milk).

Mango kernel – A highly nutritious food: From the data reported in the literature and that summarized above, it is very clear that mango kernel is a very nutritious food. It provides almost all the essential nutrients for our body and a major portion of RDA when taken in sufficient quantity. Per unit weight, the kernel has significantly more (10-100 times more) nutritional values than mango pulp. It has a nearly balanced quantity of protein (all essential amino acids), carbohydrates and oils. It is a good food after cooking (boiling or roasting). A variety of nutritional dishes, starting from curry, bread, milk (like almond milk), snacks, deserts/sweets and many specialty dishes can be prepared. Instead of being discarded, it should be consumed.

Economics: The proper utilization of mango kernel holds a great economic potential. Forty million tons of mangoes contain nearly eight million tons of the kernel or eight billion kilograms of the kernel. Highly nutritious food like mango kernel can be sold for a US dollar to five US dollars per kilogram. At that prices, mango kernel is worth at least about ten billions of dollars. A variety of businesses can be created, for example, providing mango kernel flour and roasted kernels and pharmaceuticals made from phytochemicals for treating or preventing disease. It can also employ many people.

Mission

Only a small portion (e.g., about 10%) of mango is processed for products, such as canned slice and pulp, ice cream and pickles (in India). About 90% of the mangoes are used at home and the kernel is discarded. Recovering mango pit or making people use mango kernel is not a simple task. If people know the nutritional and therapeutic values of mango kernel, it is likely that they will collect the pit during the mango season and use dried kernel for the rest of the year. In order to utilize the kernel, we suggest the followings:

- Make people aware of nutritional and therapeutic values of mango kernel.
- Make aware and encourage media, such as newspapers, TV and radio to promote the utilization of mango kernel.
- State and federal governments and NGOs should get involved in the awareness and promotion.
- Develop ways to promote use of mango kernel, e.g., some kind of incentive for collecting and returning the pit.
- Develop and supply inexpensive nut cracker for the pit.
- Develop dishes for utilization of the kernel.

Let this be a mission of people, society, academic institutes and governments of mango producing countries. We consume a wide variety of fruits but we barely use seeds/kernels/nuts of many fruits. Many of the kernels are very rich in in a variety of nutrients and phytochemicals. We should explore how these seeds, for example, those of papaya, *Java Plum* and *sapotas*.

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References

1. MA Fowomola. African Journal of Food Science, for nutrients of mango seed. 2010; 4:472-478.
2. Bally ISE. *Mangifera indica* (Mango), ver. 3.1. In: Elevitch, C.R. (ed.). Species Profiles for Pacific Island Agroforestry. Permanent Agriculture Resources (PAR), Hōlualoa, Hawai'i, 2006. [http://www.traditionaltree.org/\(www.fozli.com/ebook/Mangifera-mango.pdf\)](http://www.traditionaltree.org/(www.fozli.com/ebook/Mangifera-mango.pdf)) and <https://ndb.nal.usda.gov>.
3. <https://www.health-alternatives.com/nutrient-chart-e-book.html>
4. <http://www.myfitnesspal.com/food/calories/168890796>
5. Suk-Hyun Choi, Nobuyuki Kozukue, Hyun-Jeong Kim, Mendel Friedman, Analysis of protein amino acids, non-protein amino acids and metabolites, dietary protein, glucose, fructose, sucrose, phenolic, and flavonoid content and antioxidative properties of potato tubers, peels, and cortexes (pulp), Journal of Food Composition and Analysis. 2016; 50:77-87.
6. Cristian Torres-Leon, Romeo Rojas, Juan C. Contreras-Esquivel, Liliana Serna-Cock, Ruth E *et al.* Aguilar Mango seed: Functional and nutritional properties Trends in Food Science & Technology. 2016; 55:109e117.
7. Kittiphoom S. Utilization of Mango seed International Food Research Journal. 2012; 19(4):1325-1335.
8. H Rymbai, M Srivastav, RR Sharma, CR Patel, AK Singh. Bio-active compounds in mango (*Mangifera indica* L.) and their roles in human health and plant defence: A review Journal of Horticultural Science & Biotechnology. 2013; 88(4):369-379.
9. Shilpa Yatnatti, D Vijayalakshmi, R Chandru. Processing and Nutritive Value of Mango Seed Kernel Flour Current Research in Nutrition and Food Science. 2014; 2(3):170-175.
10. Baptist NG. Essential Amino-acids of some Common Tropical Legumes and Cereals British Journal of Nutrition Cited by. 1954, 8(3). <https://doi.org/10.1079/BJN19540034>
11. Savolainen H. Tannin content of tea and coffee. J Appl Toxicol. 1992; 12(3):191-2.