

# A REVIEW ON YAM BEAN MILK: APPLICATION IN PRODUCTION OF PHYTOSTEROL ENRICHED CHOCOLATE

## Abstract

This study is focused on using yam bean milk in application of making phytosterol (PS) enriched chocolate. In recent decade the health awareness has increased among people creating a massive ongoing demand for healthier versions of daily favourite snacks which definitely includes chocolate. Following the above-mentioned inspiration this study aims to find a healthier alternative of chocolate which will contain Phytosterol, structural components of biological membrane of plant with structure similar to cholesterol, but helps to reduce absorption of cholesterol. This study will show the process of substitution of cow milk, one of the main ingredients of making milk chocolate with the milk of yam bean locally known as jicama. This will give the product not only the antioxidant, gut friendly properties but also making it dream come true for lactose intolerant & vegan people.

**Keywords:** Yam Bean milk, Phytosterol, Chocolate, Antioxidant, Lactose intolerance

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## I. INTRODUCTION

Chocolate is a food made from roasted and ground cacao seed kernels that is available as a liquid, solid, or paste, either on its own or as a flavouring agent in other foods. Cacao has been consumed in some form since at least the Olmec civilization (19<sup>th</sup> - 11<sup>th</sup> century BCE). Chocolate is one of the most popular food types and flavours in the world, and many foodstuffs involving chocolate exist, particularly desserts & it's also being one of the most used flavours in confectionery industry.<sup>[1]</sup>

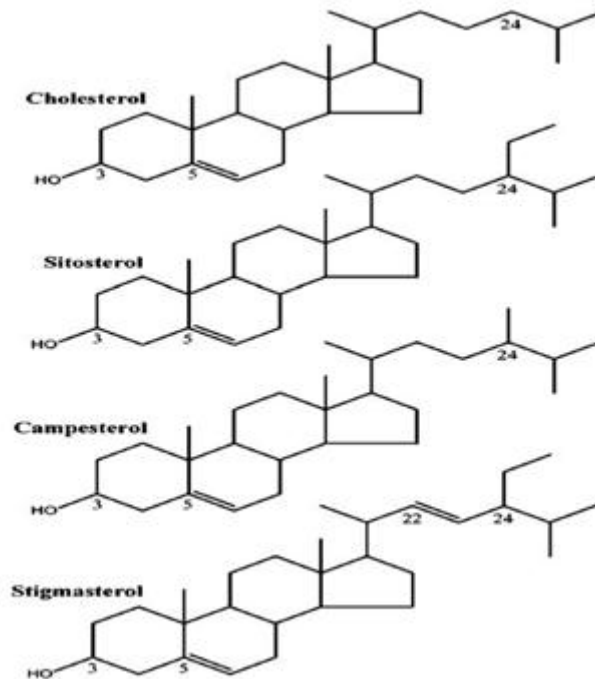
The seeds of the cacao tree have an intense bitter taste and must be fermented to develop the flavour & after that drying, cleaning & roasting follows. The shell is removed to produce cocoa nibs, which are then ground to cocoa mass, unadulterated chocolate in rough form. Once the cocoa mass is liquefied by heating, it is called chocolate liquor. The liquor may also be cooled and processed into its two components: cocoa solids and cocoa butter.<sup>[2]</sup>

In the late 1800s France & Switzerland manufactured most eating chocolates & they mainly produced drinking cocoa or chocolate. Then in new century different companies started making unique tasting chocolate bars. Peoples demand of unique tasting chocolate grew in the market, making a new technological innovation required. In 1935 a method was found of putting air bubbles into chocolate & a new chocolate bars became more novel in colour, smoother & richer in taste.<sup>[3]</sup> Milk chocolate is solid chocolate bar, which is made with dried milk aka milk powder or condensed milk or liquid milk. White chocolate is made of sugar, milk powder, cocoa butter without the cocoa solids. Dark chocolate, known as plain chocolate is traditionally made with higher percentage of cocoa without any added milk, only with cocoa butter but there are different types of hybrid dark chocolate in market with different percentage of added milk.<sup>[4][5]</sup> The milk that has been being used in chocolate making is mainly cow milk. In current years due to different dietary needs being known, lack of availability of cow milk, Increased demand of dairy products but lack of resources manufacturers are trying to find different alternative of cow milk. This change is being initiated not only in chocolate making, almost in every industry that includes using cow milk. Popular alternatives of cow milk in market are soy milk (milk made from soybean), Oat milk, Coconut milk, Almond milk, Rice milk, Cashew milk, Macadamia milk, Hemp milk, Quinoa milk, Hazelnut milk etc. Though in current market still there is no successful or popular alternative of cow milk. This study focuses on finding a successful alternative of dairy for making milk chocolate or white chocolate, that's why, this paper is introducing the application of milk of Yam bean aka jicama to make chocolate.

Before this paper digs dipper into yam bean milk, there is a question “what is Phytosterol enriched chocolate ?” To understand that we need to know what Phytosterol is at first. Phytosterols also known as plant sterols (PS) are found in cereals, seeds & also in vegetable oils. It has similar molecular structure as cholesterol. We most frequently can find  $\beta$ -phytosterol, campesterol and stigmasterol PS in nature.<sup>[6]</sup> PS has high hydrophobicity, due to that PS molecules are able to displace cholesterol during micelle formation in the intestine.<sup>[7]</sup> That is how cholesterol absorption gets reduced. PS helps to reduce the activity of acetyl-coenzyme A acetyltransferase (ACAT), which re-esterifies cholesterol, which is a necessary step for its incorporation into chylomicrons.<sup>[8]</sup> PS are natural compounds which can be taken as drugs or we can add this to some food formulations. To claim the health benefits of PS there are several fortified foods are being created which includes dairy products, snack

bars, sausages, bakery products, spreads, cereals, salad dressings, breads, orange juice and of course chocolate.<sup>[9]</sup> In most of these food products the doses of PS ranges between 2-3gm.<sup>[10]</sup>

In recent years the FDA has revised its regulations about using PS in the food products. According to FDA functional foods should provide at least 0.65 g of vegetable oil sterol esters, eaten twice a day with meals for a daily total intake of at least 1.3 g.<sup>[11]</sup> According to some epidemiological and clinical studies done in recent years, it is seen that the diary intake of 2 g of PS could result in average 8.8% of LDL-cholesterol reduction.<sup>[12]</sup>



**Figure 1:** Different Types of Sterols

Phytosterols resemble cholesterol in function by stabilizing phospholipid bilayers in cell membranes and similar structural pattern of steroid nucleus,  $3\beta$ -hydroxyl group, 5,6-double bond. Most Phytosterol side chains contain 9 or 10 carbon atoms, meanwhile the cholesterol side chain is comprised of only 8 carbon atoms.<sup>[13]</sup> The cell structure of PS is similar to cholesterol, so it competes with cholesterol for absorption by digestive system. When body digests plant sterols instead of cholesterol, it removes some of the cholesterol as waste. This results in lowered cholesterol levels and improved health.

In recent years there has been few studies about potential effectiveness & mechanism of PS on different form of cancer. There are considerable amounts of emerging evidence which supports the inhibitory actions of plant sterols on lung, stomach, and also on ovarian and breast cancer which is predominantly seen in women. Researchers observed that PS works through action of multiple mechanism which includes inhibiting the process of carcinogen production & cancer cell growth, developing new blood vessels (angiogenesis), invasion of metastasis and also by promoting apoptosis (process of programmed cell death)

of cancerous cells. Phytosterol consumption also helps to increase the activity of antioxidant enzymes causing in the reduction of oxidative stress.<sup>[14]</sup>

Though PS comes with all these benefits, but researchers are still speculating some side effects. Plant sterol are susceptible to oxidation & can create POPs aka Phytosterol Oxidation Products which includes several types of hydroxy, epoxy, keto, and triol derivatives. This happens when PS is subject to long term storage.<sup>[15]</sup> POPs presents completely opposite health effects of plant sterols by showing toxic effect on human & animals. It can invalid the hypocholesterolaemic actions of plant sterols.<sup>[16]</sup>

Now we need to know what yam bean is. Yam bean also known as jicama or Mexican turnip is the tuberose root of the plant from fabaceae family. It's scientific name is *Pachyrhizus erosus*. It's native to humid tropical areas of Africa, it's mainly seen in Indian market in the season of winter. Yam bean contains 38kcal energy, 9gm carbohydrate, 0.7gm protein & 0.1gm fat & 6.4gm of dietary fibre in every 100gm. It contains higher percentage of vitamin C & also a good source of folate, iron, manganese, potassium & magnesium.

Yam bean is medicinal plant with potent therapeutic effects against disease. However there are very few works on yam bean's potential health benefits. In a research scientists extracted yam bean fibre and gave it to adult male mice in 10% dosage with high fat diet. They observed those mice for ten weeks. After that time period it was seen that excessive weight gain & white adipose tissue mass inhibited but the brown adipose tissue mass was sustained. Furthermore, YBF sustained normoglycaemia (normal blood sugar level), glucose tolerance, and insulin sensitivity.<sup>[17]</sup>

In another research the effectiveness of jicama on type two diabetes mellitus is observed. They used adult male mice for the study & fed them normal diet & HFD with 10% & 25% YBF supplements. After 8 weeks of observation and measuring random blood glucose, fasting blood glucose, glucose tolerance it was seen that YBF prevented marked increase of random & fasting blood glucose levels & sustained glucose tolerance of mice who was having HFD. After observing histopathological alterations of pancreas it was noticed that YBF prevented hypertrophy & hyperplasia in islets of Langerhans & it also prevented ectopic fat deposition in pancreas.<sup>[18]</sup>

Fisetin (3, 7, 3', 4'-tetrahydroxyflavone) is a flavonol which is present in jicama. A research has been conducted which shows fisetin's protective effect against UV rays. It's particularly effective for B16F10 cells, human skin fibroblasts, and 3T3-L1 cell. Here in vivo animal study two adult mice & they were given doses of 25mg & 50mg / kg of body weight. After keeping them under UVB radiation for 20 days it was seen that melanin accumulation on skin is inhibited depending on dosage. Also collagen, pro-collagen, elastin, fibronectin was increased after fisetin treatment.<sup>[19]</sup>

Jicama helps to take a good care of heart health by lowering cholesterol levels. In a study researchers choose 18 people & fed them jicama yogurt for 14 days. Initially the average cholesterol level of subjects is 218.33 mg/dl , HDL 51.11 mg/dl, LDL 145.11 mg/dl, Triglyceride 111.39 mg/dl. After the observation period whether their Biochemical tests were done lowered levels were seen. Average reduction was 0.56 mg/dl, LDL 5.56 mg/dl, Triglyceride 2.17 mg/dl & an average increase in HDL level of 5.56 mg/dl.<sup>[20]</sup>

Yam bean is high in dietary fibre which helps to bulk the stool & makes it easier to pass through. It specifically contains a fibre called “inulin” which helps in bowel movements. Jicama is a Prebiotic so, it increases good gut bacteria & Decreases bad gut bacteria. It also has high levels of vitamin C, beta carotene & selenium so it helps to prevent ROS cell damage.

Last but definitely not the least important aspect of this study cocoa. Cocoa is well known nutraceutical. Cocoa is rich in polyphenol.<sup>[21]</sup> Now in recent studies have properly mapped cocoa’s metabolism pathways it can be seen that it helps in weight loss by mitochondrial biogenesis.<sup>[22]</sup> Cocoa butter is an amazing source of vitamin E which supports eye, brain and reproduction health. Phytochemicals in cocoa butter helps to prevent UV rays damage. It contain stearic acid which gets converted into oleic acid by liver which helps to lower LDL & boosts HDL. It also contain choline which helps in liver diseases & also contains vitamin K which improves bone health.

Now this study aims to utilize all of the ingredients cocoa solids, cocoa butter, yam bean & Phytosterol, combine their health benefits and propose to make a healthier versions of everyone’s favorite comfort food chocolate.

Chocolate can be prepared in different methods. At first the yam bean tubers are thoroughly cleaned in water making sure there is no dirt on them. Then peeled properly & chopped in equal pieces. Then the chopped pieces sprayed down thinly & separately in trays with paper towel underneath. Then they are dried in mechanical drier. Then the dried slices are milled using a hammer mill. Milling should be done until it turns into dust. This is how powdered yam bean is prepared.<sup>[23]</sup>

For making milk chocolate cocoa nibs are grounded in refining mills. Cocoa nibs contains 53% of cocoa butter. Heat generated cause of the grinding makes the butter melt & form fine paste which is called chocolate “liquor”. After that 80% of cocoa butter is removed & Yam bean powder, sugar is added into it and then it’s tempered to give it proper texture and then its put on mould, Phytosterol is added & let it rest.

For making white chocolate Cocoa butter, yam bean milk powder & sugar is added to a food processor and let it grind until it forms a smooth paste. Then let it temper, put in a mould and add PS & let it rest.

## II. CONCLUSION

This review study may help to prevent cholesterolemia and can promote heart health, help in cancer prevention. Children or adults everyone loves chocolates, but because of different dietary needs some have to refrain from having chocolate, this product can be new hit for vegan & lactose intolerant people. This food product formulation can bring light to new food product development, food technology, food & confectionery science and other related fields.

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