

# Impact of Dehydrated Jackfruit in the Acceptance of a Probiotic Fermented Milk

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**Abstract--** This research was conducted to study the impact of the addition of dehydrated jackfruit in a probiotic fermented milk. To add value to jackfruit it was dehydrated and cut (into two different forms), subsequently it was added in stirred probiotic fermented milk. The dehydration process occurred as follows: initially the fruit was sanitized, peeled and the bulbs were submitted to an osmotic dehydration, in a solution of 40 % of sucrose and 0.3 % of citric acid at 100°C for 10 minutes. Then they were dried in a convective dryer at 60°C for 6 hours. Two formulations of stirred probiotic fermented milk with dried jackfruit were developed: Formulation A with dehydrated jackfruit cut into cubes of 0.5 cm and Formulation B with dehydrated jackfruit crushed (almost disintegrated). For the milk fermentation at 43°C was used tree lactic acid bacteria: *Streptococcus thermophilus*, *Bifidobacterium animalis* and *Lactobacillus acidophilus*. The fermentation was ended when the product reach the pH 4.6, than it was cooled and the gel was broken and mixed with 15 % of dehydrated jackfruit (w/w). To evaluate the hygienic-sanitary conditions of the stirred fermented milk, the enumeration of yeasts and molds, total coliforms and fecal coliforms were performed before the sensorial evaluation. All counts were below the maximum allowed by the Brazilian legislation. The counts of *Bifidobacterium animalis* was 10<sup>9</sup> CFU/g so this product can have a claim functional food as probiotic. In the sensory evaluation, both formulations showed a high level of acceptance, once 82 % of the panelists liked the Formulation B (scored the product between grade 9 and 6) and 98% liked the Formulation A. There was significant difference (p < 0.05) in overall acceptance and formulation A was preferred. In the sensorial evaluation the attributes scored were: sweet taste, jackfruit flavor, texture and the overall acceptability. It was also analyzed the purchase intention using a three-point hedonic scale, 78 % of the panelists said that they definitely would buy the Formulation A and 48 % the Formulation B. These results

indicate that jackfruit could be successfully incorporated into different products in the food industry.

**Index Term-** jackfruit, dehydration, fermented milks, probiotics, sensory evaluation

## I. INTRODUCTION

Among regional, exotic and tropical fruits, jackfruit has a wide acceptance due to its sweet taste and characteristics flavor and aroma. The jackfruit tree (*Artocarpus heterophilus* Lam) is originally from India, but it was widely cultivated in several tropical countries such as: Southeast Asia, Indonesia, southern China, Philippines middle Africa and Latin American countries (SAXENA et al., 2009). In Brazil it was introduced by the Portuguese in the seventeenth century, it is currently cultivated in the Amazon region and all over the Brazilian coast. The specie is typically tropical climate and it requires hot and humid weather to produce good quality fruits (SILVA, 2002).

Jackfruit is rich in fiber, calcium, phosphorus, iron and B vitamins, particularly Riboflavin and Niacin. Considering the consistency of the pulp of fruits and the varieties, jackfruit are classified as: hard jackfruit (which is larger and it has a firm flesh) and soft type (smaller fruits, soft bulbs and sweeter). Although jackfruit is often consumed *in natura*, without any kind of processing, this fruit is very perishable and due to that there is a great loss of it all over the world. For this reason, it is very important the development of new products with longer shelf life to aggregate value to jackfruit (JAGTAP and BAPAT, 2010).

The jackfruit has a great importance regarding the economical, social and feeding aspects, but it was not been enough explored yet, it has a low commercial value. After cut and pitting the jackfruit, the bulbs (which is the edible portion), yields around 30-35% of the whole fruit. Therefore, it is important to process the jackfruit to add value to the fruit and to be possible to store and transport it. Different products were developed to preserve jackfruit such as a fruit bar (Manimegalai et al., 2001), canned juice (Seow and Shanmugam, 1992), bulbs have also been subjected to blast or cryo-freezing to extend the shelf-life (John and Narasimham, 1998). The minimally processing was also used to extend shelf-life of jackfruit bulbs (SAXENA et al., 2008). Osmotic dewatering combined with acidification, in-pack pasteurization and refrigeration were also used to preserve jackfruit (SAXENA et al., 2009).

The demand for natural and healthy products, as well as adding value to regional raw materials has increase interest, not only in the finished products, but also to obtain different ingredients that can be used in several foods such as dairy, confectionery and bakery products (LIMA et al., 2004).

The osmotic dehydration (OD) is a technique which consists in immersing the food in hypertonic solutions with one or more solutes, it allows the reduction of water content, and the impregnation of different solutes in foods modifying their physicochemical and nutritional characteristics (SAXENA et al., 2009). Dehydration changes the characteristics of jackfruit and the final product can be eaten direct as a snack or it can be added to different products.

The fermented milks are widely consumed all over the world, it has a high nutritional value and also it can be considered as a functional food. However, the natural flavor of fermented milk without sugar and fruits, is not so appreciated, therefore, the dairy industry is always developing products with different fruits or flavor to improve their products and increase sale (SANTOS et al., 2011).

The addition of different fruits is interesting and it is a viable alternative to aggregate value to the fermented milk. The fruits can be added to the fermented milk in different ways, such as: a jelly, preserved in syrup, frozen or dried. In general, fruit preparations for the dairy industry includes: fruits, sugar (syrup and/or artificial sweeteners), stabilizers, flavors and coloring (TAMIME and ROBINSON, 2007).

Even with so many possibilities of fruit, only a few varieties are ordinarily used in commercial fermented milk, like: strawberry, coconut, peach and fruit salad. But lately it is possible to observe in the market new flavors, notably with tropical fruits in order to increase sales and competition among the industry (TAMIME and ROBINSON, 2007).

The survival of probiotics in the fermented milk are influenced by many factors such as: the presence of other micro-organisms, the food matrix in which they had been added, addition of different kinds of fruit and ingredients, processing conditions, type of packaging and other factors (SANTOS et al., 2011).

In the food industry, especially in dairy area is observed a tendency to develop functional products. The

probiotic bacteria have the ability to settle and colonize the intestine colon and confer different benefits to the host health, such as: modulation of the intestinal microbiota (due to the production of antimicrobial compounds, by the competition for adhesion sites and nutrients); system stimulus immune to the host (increases in antibody levels and macrophages activity) and stimulation of the absorption of certain nutrients (SAAD et al, 2013).

The probiotics most widely used in the fermented milk are: *Lactobacillus acidophilus* and different species of *Bifidobacterium*. The consumption of probiotics should range from  $10^9$  to  $10^{10}$  CFU per 100 grams of product, which is sufficient for the maintenance of physiologically active concentrations ( $10^6$  to  $10^7$  CFU.g<sup>-1</sup>) *in vivo* (SAAD et al, 2013).

The addition of dried jackfruit in stirred probiotic fermented milk could be an interesting alternative for the diversification and to aggregate value to the jackfruit. The jackfruit provides the aroma and flavor of this tropical fruit. In this research was developed and characterized two different formulations of stirred probiotic fermented milk with dehydrated jackfruit (cut into cubes and crushed/disintegrated).

## 2. MATERIAL AND METHODS

### 2.1. MATERIAL

The ingredients used for the formulation of fermented milk were: UHT milk, skim milk powder and sugar which were purchased in a local supermarket. The jackfruit (type "hard") was purchased at Municipal Market and transported to the Vegetal Processing Laboratory of the Food Technology Department of Federal University of Sergipe (UFS) where it was processed. The fruits were selected according to the maturation stage that was evaluated by the skin color (it should be dark green) and by its characteristic and pronounced aroma and flavor.

### 2.2. DEHYDRATATION OF THE JACKFRUIT

The jackfruit was washed in running water, immersed in a solution of 200 ppm sodium hypochlorite for 15 minutes. It was cut in half to remove the bulbs and each bulb was cut to remove its seeds.

Then the bulbs were subject to an osmo-blanching in a solution of sugar (40% of sucrose) and citric acid (0.3%) for 10 minutes at 100°C.

Then the bulbs were drained for one hour to remove the excess of liquid and were transferred to dehydrator trays (Mark Sparrow, model PE 100). The dehydration was carried out in a convective dryer with forced air circulation at 60°C for 6 hours. The trays with the samples underwent into a 180° rotation every hour, this change of the position in the dryer, enabled to obtain a homogeneous dehydration.

The dehydrated jackfruit was divided in two parts, and half of it was cut into cubes of 0.5 cm of edges and the other half was crushed in very small pieces (almost disintegrated) in a multiprocessor (Arno brand). And both were kept under refrigeration in plastic bags until the mixture

with fermented milk. The appearance of jackfruit bulbs *in natura* and after dehydration can be observed in the Figure 1.



Fig. 1. Samples of jackfruit bulbs *in natura* after the osmo-blanching in sugar and citric acid solution (1A) and jackfruit bulbs after dehydration (1B).

### 2.3. FERMENTED MILK

For the fermented milk production it was used UHT milk, 6% of sugar (w/w) was added and then it was submitted to a heat treatment (95°C for 5 minutes). Subsequently, 5 % (w/w) of skim milk powder was added and mixed. The milk was cooled to 43 °C, and then it was added 5 % of a commercial mixture of probiotic lactic acid bacteria LYOFAS<sup>TM</sup> SAB 440A (Sacco) with *Lactobacillus acidophilus*, *Bifidobacterium animalis* ssp. *lactis* and *Streptococcus thermophilus*. The fermentation was carried out in an incubator chamber at 43 °C until the product reached a pH of 4.5 and afterward it was cooled to 4 °C to stop the fermentation and to preserve the final product until the analysis.

It was developed two formulations: Formulation A with cubes of dried jackfruit and Formulation B with crushed dried jackfruit. In both formulations it was blended 15 % of dried jackfruit (cut or disintegrated) with 85 % of fermented milk. The final products (A and B) were kept in sealed containers (plastic cup) under refrigeration until the analysis.

### 2.4. METHODS

The physicochemical analyzes of the dried jackfruit and the two formulations of fermented milk were carried out according to the methodologies proposed by the A.O.A.C (2005). The total soluble solids was determined using a refractometer and pH using a digital pH meter.

The yeast and mold, total coliforms and the fecal coliforms enumerations were conducted to evaluate the hygienic-sanitary conditions of product. The count of yeast and mold, total coliforms, fecal coliforms, *Streptococcus thermophilus* and *Lactobacillus acidophilus* were performed according to APHA (2004) and the enumeration of *Bifidobacterium* according to Vinderola et al. (2000).

To evaluate the acceptance and the purchase intention of both formulations were used the methodologies proposed by Meilgaard et al. (2007). For the sensorial analysis it was

used 50 untrained panelists recruited among students, professors and employees of the Federal University of Sergipe (UFS). The samples were coded with three digits and were served in a monadic way, in a disposable plastic cups with 30 grams of cooled sample.

In the acceptability evaluation the following attributes were analyzed: sweetness, jackfruit flavor; texture and overall acceptance. It was used a nine-point hedonic scale where “one” meant really dislike it and “nine” meant like it extremely.

The purchase intention was evaluated using a three-point hedonic scale where the “one” meant certainly would buy, “two” maybe would buy and “three” certainly would not buy.

The processing and the analysis were performed in duplicate and all the results presented in this study are the mean values. Data were submitted to ANOVA (7.5 Beta Assisat software) followed by the Tukey’s means comparison test ( $p < 0.05$ ).

### 3. RESULTS AND DISCUSSION

The dried jackfruit was darker than the fresh fruit (which can be observed in Figure 1). The dried fruit had  $26.30 \pm 0.95$  % of moisture; pH of 4.8 and a content of total soluble solid of  $61 \pm 1^\circ$ Brix. The dried jackfruit in this study had composition similar to others researches depending on the treatment (temperature of drying, addition of acid and the concentration and the type of sugar used) that jackfruit was submitted (OLIVEIRA et al., 2011).

The formulations A and B of the jackfruit fermented milks presented: 0.62 % of lactic acid; 78.52 % of moisture; 4.90 % of protein; 2.9 % of fat; 1.1 % of ash, pH of 4.5 and 19°B. All the parameters were in accordance with the Brazilian legislation for fermented milk and also in the same range that is observed in the literature.

The pH of the products were higher than what was observed by Medeiros et al. (2011), in a stirred yogurt made with a jackfruit jelly which had a pH of 4.0. The composition of the final product were very similar, but they found lower fat

content (2.05 %); similar protein concentration (4.97 %); moisture that varies from 78.87 to 74.50 % and lower ash that varies from 0.96 to 0.98 %.

In this research, before the sensory analysis be performed, both formulations underwent to microbiological analysis. The thermotolerant coliforms (45°C), total coliforms and molds and yeasts were counting to evaluate the hygiene of the process. In both formulations, the counts of coliforms were  $< 3.0 \text{ MPN.g}^{-1}$  under the maximum permitted ( $10 \text{ MPN.g}^{-1}$ ), and the molds and yeasts under  $1 \times 10^2 \text{ CFU.g}^{-1}$  and therefore both formulation were safe to be evaluated by the panelists.

The lactic acid bacteria counts (was greater than  $10^7 \text{ CFU.g}^{-1}$  which is above the minimum count required for fermented milk) and the counting of *Bifidobacterium* was  $1 \times 10^9 \text{ CFU.g}^{-1}$  which was enough to confer a functional claim of probiotic product.

In Table 1 can be observed the means of the different attributes evaluated on the sensorial acceptability. These results showed a high acceptability of both formulations which were scored between grades seven and eight that correspond to "liked moderately" and "really liked it".

The attributes flavor of jackfruit and texture had averages above seven, but there was no significant difference between the formulations for these attributes. There was significant difference in the attributes sweet and overall acceptance, the formulation with dried jackfruit in cubes had a higher acceptability than the one with chopped jackfruit.

Table I

Average of the different attributes evaluated in the sensorial acceptability of fermented milk with dehydrated jackfruit (in cubes and chopped).

Formulation	Sweetness	Jackfruit flavour	Texture	Overall acceptance
A: Fermented milk with jackfruit in cubes	7,86 <sup>a</sup>	7,64 <sup>a</sup>	7,44 <sup>a</sup>	7,82 <sup>a</sup>
B: Fermented milk with chopped jackfruit	7,12 <sup>b</sup>	7,24 <sup>a</sup>	7,02 <sup>a</sup>	7,12 <sup>b</sup>

The same letters in the column means there was no significant difference ( $p < 0.05$ ).

The texture was the attribute with the lowest scores in the two formulations, ranging from "liked moderately" and "really liked". The attributes sweetness and overall acceptance had a high scored, in formulation A, 7.86 and 7.82 respectively, almost eight which means "really liked." In this research, the acceptance was higher than what was observed by Medeiros et al. (2011), which had the overall acceptance ranged from 6.3 to 6.8. Medeiros et al. (2011), scored for texture from 7.56 to 6.80 similar to this study in the same range from this research that was from 7.02 to 7.44.

The fermented milk with jackfruit into cubes (formulation A) had a higher acceptance, 18% of the panelist liked moderately, 52% really liked it and 24% extremely liked it, while in the case of the product with chopped jackfruit (formulation B), 30% of the tasters liked moderately, 38% liked it a lot and only 8% extremely liked it.

In general, both formulations developed had a good sensorial acceptance, but the fermented milk with crushed jackfruit obtained a lower acceptance, 82% of the tasters assigned scores ranging from "like slightly (6)" and "like extremely (9)" to this product, while 98% attributed this same range for the product with the jackfruit into cubes.

The results of the purchase intention test which can be observed in Table 2. It showed a good purchase intention for fermented milk with dried jackfruit. Formulation A showed a higher purchase intention, once 78% of the panelists said they definitely would buy the product, only 48% definitely would buy the formulation B. This purchase intention test confirms the result of the acceptance test, where it was observed that the fermented milk with jackfruit cubes (Formulation A) had a higher sensorial acceptance.

Table II

Results of purchase intention test of fermented milk with dried jackfruit.

	Formulation A	Formulation B
Definitely would buy (%)	78	46
Probably would buy (%)	20	48
Definitely would not buy (%)	2	6

Oliveira et al (2008) working with Araticum (*Annona crassiflora* Mart.) yogurt, another tropical fruit observed that in the purchase intention 55% of panelists said definitely would buy the product developed, lower than what was observed in this work with the fermented milk dried jackfruit in cubes (Formulation A). Medeiros at al (2011) also observed a much lower purchase intention; only 20 to 24% of the panelist said they definitely would buy the yogurt with jackfruit jelly.

Although dried jackfruit it is not well-known and also not commercially available in the market, different studies observed that it is appreciated by the panelists (OLIVEIRA et al., 2011). So dehydration it is a good way to add value to jackfruit, improving the shelf life and it is also an interesting product for the dairy industry.

#### 4. CONCLUSIONS

The results of this research revealed that a probiotic fermented milk with dried jackfruit had a very good acceptance by panelists, specially when the fruit was cut into cubes. So this could be an interesting using dried jackfruit and it is a very good way to aggregate value to the jackfruit.

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