EXTENDED ABSTRACT

COMPARATIVE STUDY ON THE NUTRITIONAL PROPERTIES OF BANANA, JACKFRUIT AND PUMPKIN FLOUR

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Abstract

The objective of the present study was to evaluate the nutritional properties of jackfruit (*Artocarpus heterophyllus*), pumpkin (*Cucurbita maxima*) and green banana (*Musa acuminata*) flours. Fresh slices of each crop were dried at 60 °C in a hot air dryer until the moisture content reached to 6%. Dried samples were ground and screened through a 0.5 mm sieve to obtain flour. Flours were separately stored in airtight containers till further use. The proximate composition was determined using the standard AOAC methods. The crude protein, crude fat, total ash and crude fiber contents recorded on dry weight basis were 4.86±0.23%, 0.15±0.07%, 1.95±0.02%, 2.72±0.03% in jack fruit flour; 4.45±0.09%, 0.75±0.01%, 3.03±0.04%, 8.75±0.01% in pumpkin flour and 4.43±0.03%, 0.24±0.03%, 2.81±0.02%, 1.16±0.01% in green banana flour respectively. The significantly ($p \leq 0.05$) higher contents of total ash and crude fiber in pumpkin flour open up avenues for surplus utilization and for a demand driven cultivation that ensures raw materials with better nutritional profile. Moreover, these are better substitutes for imported wheat flour.

Keywords: Post-harvest losses, proximate composition, value addition, wheat flour substitutes

1. Introduction

Food loss and waste are global scenarios which include the post harvest losses of fruits and vegetables along the food chain with a total annual loss of US$ 750 billion (FAO, 2013). During the peak season, fruits and vegetables create a surplus of production whereas during the off season, they create a higher demand with drastic price fluctuations (Rahman et al., 2012). Most of the fruits and vegetables deteriorate within the season due to their perishable nature and enzyme activities. All these factors discourage the growers from producing more.

Banana (*Musa acuminata*) is the main fruit crop cultivated in Sri Lanka. It is a highly perishable climacteric fruit which is harvested before full ripening stage and maturation continued after harvesting. Banana is susceptible to mechanical damage and pathogenic infections reducing post-harvest lifespan and increasing the losses (Maia et al., 2014). Santos et al., (2020) reported that banana has a high level of post harvest losses. The estimated total post-harvest loss of banana in Sri Lanka was about 28.5% from farm-gate to retailer (Wasala et al., 2014). Losses of pumpkin (*Cucurbita maxima*) at the farm-gate and wholesale levels have been reported in Sri Lanka. During the glut, farmers cannot sell pumpkin at a reasonable price and higher price has been observed in the off-season in Sri

Lanka (Arachchige , 2019). Jack fruit (*Artocarpus heterophyllus*) is characteristic by its perishability and seasonality. Huge loss without harvesting, lack of storage facilities, improper post-harvest handling practices and poor value addition process have been identified as the major causes for high post-harvest losses.

It is much desirable to find out a simple way to preserve these crops which can be acceptable to people for effective utilization during the season and off-season while extending the availability in a modified form. Value addition not only opens up avenues for surplus utilization, but also for a demand driven cultivation. Flour preparation is one of the effective solutions to reduce the post-harvest losses and to enhance the utilization of these crops through value addition.

The requirement of scares foreign exchange to import wheat flour and increased incidences of gluten intolerance associated with some consumers has brought the attention of researchers to develop composite flour formulas for bakery products. Noorfarahzilah et al., (2014) emphasized the importance of substitution of wheat flour with the flours from locally grown abundant raw material. It was noted that flours of pumpkin and some varieties of green banana have already been studied for their nutritional profile (Asif-Ul-Alam et al., 2014). There are many references to jackfruit seed flour related literature (Islam et al., 2015), but there is shortage of information on properties of jack fruit flesh flour. Therefore, this study was aimed at characterization and comparison of the major nutritional composition of three crops in Sri Lanka namely jack fruit, pumpkin and banana.

2. Methodology

2.1 Location

The research was conducted at the Fruit and Vegetable Processing Laboratory and Analytical Laboratory of the Food Technology Section in Industrial Technology Institute, Malabe, Sri Lanka.

2.2 Flour preparation

Matured jackfruit flesh, pumpkin and matured green bananas were washed three times by running water to remove foreign materials and dust. Dipping in Opal solution (50 ppm) for 3 min was used for surface sterilization and were washed by running water to remove excess Opal solution. Seeds/peel of jackfruit were removed, and the flesh was sliced (0.5 mm) before immersing in water. After peeling, pumpkin and banana were sliced into about 0.5 mm thickness and immersed in a 0.1% (w/v) citric acid solution. Three minutes later, all samples were steam blanched for 1.5 min and blanched slices were allowed to cool down to room temperature by immersing in a cold water bath. Blanched slices were pre-treated by immersing in a 0.1% (w/v) SMS (sodium metabisulfite) and 0.1% (w/v) citric acid solutions for 3 min each and excess solution was drained off. Slices were arranged as a single layer on a drying tray of hot air dryer and dehydrated at 60 °C up to 6% moisture content. The dried slices were ground using a Frisch mill (with 0.5 mm sieve). Flours were stored at room temperature in an airtight container (LLDPE material) for further use.

2.3 Proximate composition of flours

Moisture, crude protein, crude fat, crude fiber and total ash contents were determined according to AOAC (2012) methods. The conversion factor used for protein determination was 6.25.

2.4 Statistical Data Analysis

The statistical analysis of data was carried out for all experiments using ANOVA technique at 5% significant level ($p = 0.05$). Mean comparisons were performed using the Tukey test. For all analysis MINITAB 17 statistical software was used.

3. Results and Discussion

3.1 Hot air drying

Hot air drying has been used as a simple and common drying method for fruits and vegetables by overcoming case hardening of sample surfaces with the acceleration of drying. Hot air-dried food products contain desired color values and acceptable nutritional composition for flour.

When producing hot air-dried flours, preprocessing steps such as pre-cleaning in potable water and food grade chlorinated water were done for surface sterilization. Optimum slice thickness is important to maintain final flour quality and color profile especially in banana. Blanching and dipping in citric acid are important steps to inhibit polyphenol oxidase enzyme activity which may change the color and flavor of flour. Moreover, these steps enhance the activity of SMS by maintaining an appropriate level of pH. Application of SMS may increase the phenolic contents, bio accessible phenolics and antioxidant capacities of flour and prevents browning (Aydin and Gocmen, 2015). The above steps helped to maintain the overall quality standards of the samples.

Particle size (<0.5mm) of flour is important in rheological properties of final product. Fine particles of flours of these commodities offer better hydration capacity, and improved sensory and textural attributes for the final product.

The moisture, crude protein, crude fat, total ash and crude fiber contents of hot air-dried flours are given in Table 1 in dry weight basis.

Table 1. Proximate composition of jackfruit, pumpkin and banana flour (% w/w in dry weight basis)

Flour type	Moisture	Crude protein	Crude fat	Total ash	Crude fiber
Jackfruit flour	8.74 ± 0.04a	4.86 ± 0.23a	0.15 ± 0.07b	1.95 ± 0.02c	2.72 ± 0.03b
Pumpkin flour	5.08 ± 0.01c	4.45 ± 0.09b	0.75 ± 0.01a	3.03 ± 0.04a	8.75 ± 0.01a
Banana flour	8.32 ± 0.03b	4.43 ±0.03b	0.24 ± 0.03b	2.81 ± 0.02b	1.16 ± 0.01c
Wheat flour	12.49±0.39	8.28±0.41	1.72±0.16	1.52±0.14	NA

Values are presented as "Mean ± SD" of three independent determinations. Means within a column with different letters are significantly different ($p \leq 0.05$). NA - Not analyzed

3.2 Moisture content

Changing the perishability by value added product development increases the shelf life of fresh fruits and vegetables. High moisture content affects the shelf life of flour by accelerating mold growth, insect infestation and agglomeration. Flour specifications usually limit the flour moisture to 14% or less (Aziah and Komathi, 2009; Nasir et al., 2004). All three flour types contained a moisture content less than 10% (Table 1) which offers longer storage ability as commercial dry food products. They were lower than the moisture content of wheat flour (12.49%). Stability factors are better correlated to water activity rather than moisture content. Therefore, water activity in flour is more critical to ensure the quality and shelf life. Drying is an essential process in the preservation of agricultural products by reducing moisture content to a level, which allows safe storage over an extended period. The removal of moisture prevents the growth and reproduction of microorganisms and minimizes many of the moisture mediated deteriorative reactions and enzymatic activities. Low moisture content of flour ensures the processing of fruits and vegetables for reduction of post harvest losses.

3.3 Crude protein content

Amino acids, peptides and proteins are vital elements of food. Besides their nutritional significance, proteins contribute to physiochemical properties like texture and flavor of food. Crude protein content was significantly ($p \leq 0.05$) high in the jackfruit flour (4.86%) compared to pumpkin (4.45%)

and green banana (4.43%) flour. Aziah and Komathi, (2009) reported that protein content of wheat flour was 7.17% whereas our results showed 8.28% protein in wheat flour. On average, all three flours tested indicated a low protein content than wheat flour.

3.4 Crude fat content

Lipid compounds have nutritive and physiological importance as a source of essential fatty acids and energy supply. However, they may cause off-flavors in stored flours affecting food quality. Crude fat content was significantly ($p \leq 0.05$) higher in the pumpkin flour compared to jackfruit and green banana flour (Table 1). Crude fat content of jackfruit (0.15%), pumpkin (0.75%) and green banana (0.24%) flours were found to be lower compared to wheat flour (1.72%). Aziah and Komathi, (2009) reported a lower fat content (1.32%) in wheat flour than our results.

3.5 Crude fiber content

Crude fiber content was significantly ($p \leq 0.05$) different in the analyzed flour samples. Crude fiber contents of jackfruit, pumpkin and green banana flours were recorded as 2.72%, 8.75% and 1.16% respectively. Compared with wheat flour which contains 0.03% (Aziah and Komathi, 2009) of crude fiber, these three fruit flours contained substantial amount of fibrous material. The amount of crude fiber in the pumpkin flour was significantly ($p \leq 0.05$) higher than other two flour types. That can be considered as a suitable material to incorporate in the development of value added food products with high amount of fiber.

3.6 Total ash content

Ash content indicates the amount of minerals present in the food. Total ash content was significantly ($p \leq 0.05$) different in the tested flour samples. Ash content of jackfruit (1.95%), pumpkin (3.03%) and green banana (2.81%) flours were found to be higher (Table 1) compared to wheat flour (1.52%). These three flour types as food ingredients with high ash content can contribute significantly towards value addition of foods.

4. Conclusion

Flour preparation is one of the appropriate solutions to reduce the post-harvest losses of jackfruit, pumpkin and banana especially during the glut. Flour of pumpkin contained significantly higher amount of minerals and crude fiber compared to wheat flour. Therefore, pumpkin flour is a highly potential food ingredient to substitute wheat flour in the food industry and jackfruit and banana provide basic input materials for further value addition to open up an opportunity for field level processing factories.

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