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Development of a method for manufacturing noodles from finger millet

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Abstract

Available methods of preparing foods from finger millet at home are laborious, time consuming, and people are reluctant to prepare foods from finger millet even though finger millet is a nutritionally important food item. Also, there are hardly any food items prepared from finger millet in the market, and less attention has been given to finger millet. As a solution for this problem, a study was carried out to develop a medium scale method for manufacturing of noodles from finger millet with maximum substitution, and tests were conducted by using a process line used to manufacture rice noodles with modifications. Based on the results of the preliminary experiments, main tests were carried out with blending ratios of finger millet to rice flour percentages of 50:50 and 100:0 with three replicates. Flours were mixed with water to increase the moisture content up to 35% and pellets were formed. Paste prepared by steaming the pellets was extruded to make sheets, and they were sent to an extruder to form noodles. Formed noodles were sterilized at 100^0C, cut to 4 inches length pieces and sent to a dryer. Temperature of drying air was maintained about 40-45^0C. It was found that the moisture content and percentage total solids in gruel of both types of produced noodles were satisfied the maximum allowable level for rice noodles i.e.12% and 8% according to SLS 858. Sensory evaluation results revealed that both types of noodles produced with finger millet were highly acceptable and 100% finger millet noodles were shown a higher acceptability in colour than 50% finger millet noodles. Developed finger millet noodles packed in PET/LDPE bags can be stored more than 1.5 years without any deterioration of quality. Hence, the developed method can be used to manufacture 100% finger millet noodles commercially on a medium scale level. Cost of production is 250 SLR per kg.

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1. Introduction

Finger millet, known as kurakkan in Sri Lanka, is an annual plant widely grown as a cereal in the arid areas of Africa and Asia. Finger millet is especially valuable as it contains the amino acid methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava, plantain, polished rice, or maize meal[1]. Finger millet has good nutritional value including moisture 13.2%, protein 7.6%, carbohydrate 74.4%, fiber 1.5%, minerals 2.4%, fat 1.4%, and energy 341.6 cal/100g[2]. Finger millet has been a popular cultivation among Sri Lankan Chena farmers since ancient time and it was a major component in their meal. At present, the demand for the finger millet is increasing due to health concern. Finger millet cultivation in Sri Lanka was 5251 ha in 2011[3] and average yield was 3.0 -3.5 t/ha.

Although finger millet is a nutritionally important food item, there are no more food products in the market for consumers. There are few traditional food items such as *rotti, thalapa* etc., prepared at home with finger millet flour, but since the preparation methods are laborious, and time consuming people are reluctant to prepare these foods. There are few bakery food items in the market prepared with finger millet and these foods have been manufactured with wheat flour blended finger millet flour and not totally with finger millet. Hence, a less attention has been given to this nutritionally important food item. As a solution to this problem, a study was conducted to develop a medium scale method for manufacturing of noodles from finger millet. Noodles were selected since it is the simplest cereal product presently used in the human diet which has become popular in the diet of Sri Lankans. Noodles are widely consumed throughout the world and their global consumption is second only to bread[4].

2. Methodology

For the development of a method for manufacturing noodles from finger millet, the available rice flour noodles manufacturing process (IPHT) with modifications was adopted. The flow diagram of rice noodles manufacturing at IPHT is given in Fig.1[5].

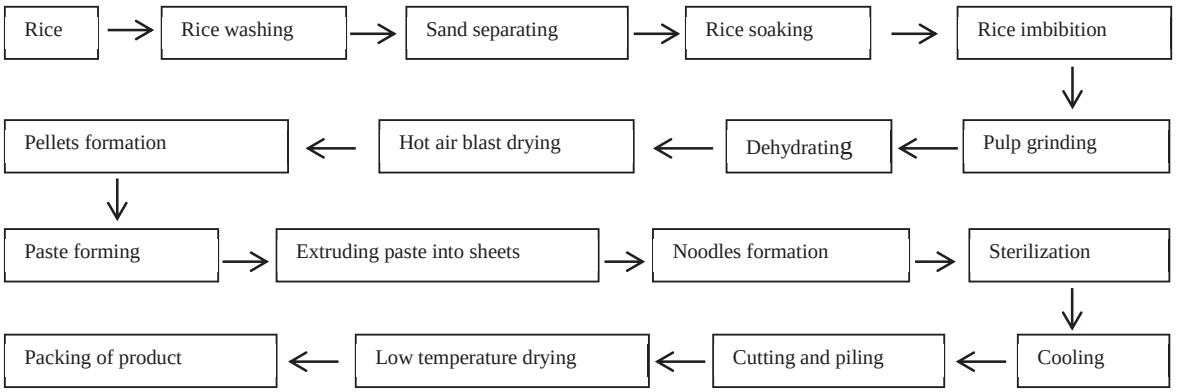

Fig.1. Flow diagram of rice noodles plant available at IPHT

Starting from the pellets formation in the above process (Fig.1), preliminary tests were carried out with different blending ratios of finger millet to rice flour percentages as 25:75, 50:50, 75:25 and 100:0. It was found that the most important properties i.e. percentage of total solid in gruel and moisture content of manufactured noodles were in an accepted level according to SLS requirement. Sensory evaluation results of preliminary tests samples were shown a higher acceptability. Noodles of the ratio of 50:50 (finger millet: rice flour) was shown a higher acceptability in colour

than 25:75 and 75:25 ratios. Hence, considering the maximum substitution with finger millet and consumer acceptability, the blending ratios of finger millet to rice flour percentages of 50:50 and 100:0 were selected for the main tests. Main tests were conducted with these two ratios with three replicates for each batch. The capacity per test was 150kg.

Finger millet and rice were ground separately by using a FFC-45 Disk mill with three numbers of passes. First pass was through 0.5mm sieve and other two passes with 0.2mm sieve. The moisture content (m.c) of the rice flour which was fed to the pellets formation screw of the above process was 35% (w.b). The available moisture of finger millet flour and the rice flour were measured, and the remaining amount of water was added to increase the final moisture content of the mixture up to 35%. Mixing of flour was done in a dough mixer with a capacity of 50kg per batch. Mixing time was 6 minutes. Water mixed flour mixture was put in to the extruder for pellets formation. The pellets were then sent to the gelatinization chamber to form the dough paste. The required steam pressure for proper gelatinization of flour was measured. The paste was then sent to an extruder to extrude the paste into two sheets and they were then sent to the noodles forming extruders. Formed noodles were sterilized at 100^0C, cut to 4 inches length pieces and sent to a dryer. Temperature of drying air was maintained at about 40-45^0C. Drying was continued until the moisture content of noodles was lowered it less than 11% (w.b.). Dried noodles product was packed in laminated (PET/LDPE) bags each containing 400g of noodles.

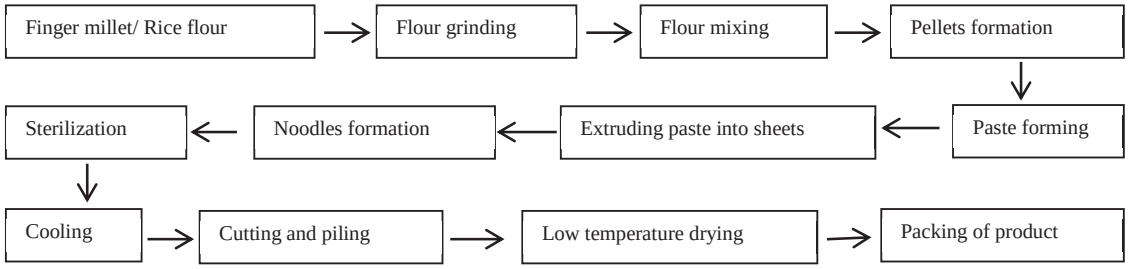

Fig. 2. Flow diagram of finger millet noodles production process

The quality of manufactured noodles was evaluated in terms of percentage of total solids in gruel, cooking time, and moisture content. The performance of the manufacturing process of noodles was evaluated in terms of recovery and breakage. Experimental design used here was completely Randomize design. Data were subjected to analysis of variance (ANOVA) using AgRes statistical package for windows version 3.01. Differences between treatment means were obtained by least significant difference (LSD) test at $p<0.05$. A sensory evaluation was conducted for evaluating the appearance, colour, odour, taste, texture and overall acceptability of the developed finger millet noodles by using 5 point hedonic scale (5= extremely like...1= extremely dislike), and the data gathered were analysed using Friedman test using Minitab 14 software package.

3. Results, Discussion, Conclusion, and Recommendations

Paste forming pressure and sterilization pressure for 50% finger millet noodles were 0.09MPa and 0.05MPa and for 100% finger millet noodles were 0.06MPa and 0.03MPa, respectively. Table1shows properties of the developed finger millet noodles and comparison of them with 100% rice noodles manufactured by the process explained in Fig.1 which was taken as the control. The moisture content and percentage total solids in gruel of developed finger millet noodles were observed to be less than the maximum allowable level for rice noodles i.e.12% and 8% according to SLS 858 and satisfied. When the amount of finger millet percentage was increased it slightly increased the percentage of total solids in gruel and reduced the cooking time.

Table 1 Moisture, total solids in gruel, cooking time, drying time, recovery, breakage, and cost of production of noodles with different finger millet percentages

	50% Finger millet	100% Finger millet	Control (100% Rice)

Moisture (%)	8.6[b]	8.1[c]	9.2[a]
Total solids in gruel (%)	6.3[b]	6.9[a]	5.4[c]
Cooking time (min.)	5[b]	3[c]	7[a]
Drying time in hr	3.9[b]	3.6[c]	4.5[a]
Noodles recovery (%)	95.3	94.1	74.2
Breakage (%)	3.8[b]	4.5[a]	3.2[c]
Production cost SLR/kg	225.00	250.00	198.00

Means in row followed by the same letter are not significantly different ($p<0.05$)

Drying time of noodles reduces with increase in percentage of finger millet. Breakage increases with increase in percentage of finger millet in noodles. Lowest breakage was observed in control (100% rice) noodles. This was due to the fact that finger millet noodles are more brittle than rice noodles. Noodles recovery was low in 100% finger millet noodles than 50% finger millet noodles. This was due to increase in breakage with increase in percentage of finger millet in noodles. The lowest recovery was observed in control (100% rice) noodles tests, and this was due to more unit operations in rice noodles manufacturing process (Fig. 1) resulting in more wastage occurred. The lowest cost of production of Rs.198 SLR per kg was estimated for the control (100% rice) noodles test. Cost of production per kg for 100% finger millet noodles and 50% finger millet noodles were 250 SLR and 225 SLR, respectively, and it was high in 100% finger millet noodles than 50% finger millet noodles. This was due to cost of finger millet flour was higher than rice flour.

Sensory evaluation results of the noodles produced with 50% finger millet flour and 100% finger millet flour are shown in the Fig. 3.

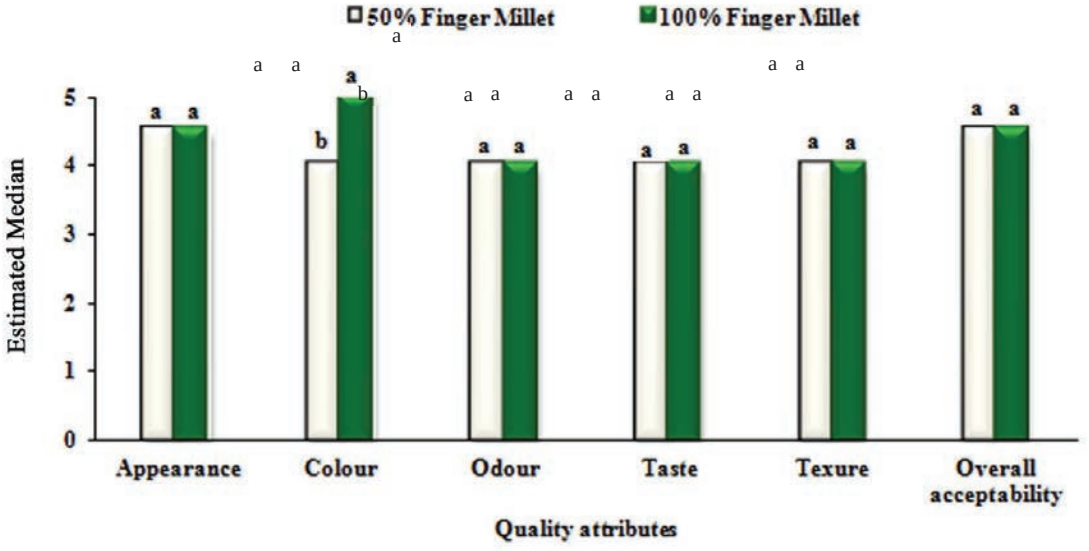

Fig. 3. Estimated median values for sensory quality attributes of noodles. Means with the same letter are not significantly different according to the least significant difference (LSD) test at $p<0.05$

Sensory evaluation results revealed that both types of noodles produced with finger millet were at highly acceptable level and there was no significant difference observed among treatments for any sensory quality attribute which tested except colour. 100% Finger millet noodles were shown a higher acceptability in colour than 50% finger millet noodles.

This study revealed the efficacy of manufacturing 100% finger millet noodles. Accordingly, the process line for the manufacture of 100% finger millet noodles were; mixing finger millet flour with water to increase the moisture content

up to 35%, forming pellets, forming paste by steaming pellets and extruded it to make sheets, form noodles by extruding sheets, sterilizing noodles at 100^0C, cut to pieces and drying noodles in a dryer maintained drying air at 40-45^0C to lower the moisture content up to 11% (wb). Quality of the developed finger millet noodles satisfied with the requirement SLS 858. And developed finger millet noodles packed in PET/LDPE laminated bags can be stored more than 1.5 years without any deterioration of quality. Hence, it can be concluded that the develop methods can be used to manufacture 100% finger millet noodles commercially on a medium scale level.

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