Development and Evaluation of Physicochemical Properties of Pulse Added Protein Rich Pasta

R. N. Balasooriya, and I. Wickramasinghe

Abstract—Sri Lanka is experiencing a nutritional transition along with under-nutrition, overweight, and obesity. Consumers are becoming health conscious and pasta products are fetching great attention. However, legumes and cereals are nutritionally complementary, where together provide the essential amino acid profile for vegans. In this study, wheat semolina was substituted with soya and mung flour to develop five pasta formulations (F1, F2, F3, F4, F5). F1 - soy 40%, F2 - soy 30% & mung 10%, F3-soy 20% & mung 20%, F4 - soy 10% & mung 30%, F5 - mung 40%. All the samples have the protein content of more than 15% which complies with the local regulation. All the five samples were evaluated for the proximate composition, cooking time and sensory qualities. Pulses incorporated pasta show increased cooking time compared to control. According to the sensory evaluation data, there is a significant difference among the five samples for color, texture, taste and overall acceptability but there is no significant difference among the sample for mouth feel of the product. Based on physicochemical & proximate composition, cooking time and sensory qualities, pasta containing soy flour (40%) resulted in better quality having more nutritional elements and highest overall acceptability.

Index Terms—Health Conscious People; Nutrition; Pasta; Protein-Rich; Pulses.

I. INTRODUCTION

Sri Lanka is a developing country which has a lower-middle-income economy. Nowadays Sri Lanka is experiencing a nutritional transition along with under-nutrition, overweight and obesity. Recent studies state that the prevalence of hypertension, obesity and dyslipidemia has been becoming epidemic in urban areas [1]. Further, one-fourth of Sri Lankan adults are suffering from metabolic syndrome, whereas one in every five adults is undergoing either diabetes or pre-diabetes. According to the Demographic and Health Survey Report – 2016 [2], overall, heart disease, high blood pressure diabetes and high blood cholesterol are mostly prevalent among older population (40 or more years of age).

Balanced diet places an important role in an individual’s health and well-being. Although both plant- and animal-based foods provide the daily protein requirement for Sri Lankans, the level of consumption of plant-based protein sources is greater than other sources. In developing countries 80% of the protein in the diet is supplied by the plant protein sources such as pulses [3].

Pasta products are fetching great attention in modern phase of civilization because of their unique properties towards health, taste and convenient for carrying and preparation. Pasta, in a broad spectrum, is considered to encompass low glycemic indices and, produce low blood glucose and insulin responses.

Although in many developing countries, rice (in Sri Lanka) contributes significantly to human daily energy and nutritional requirements, its’ amino acid profile shows that rice lacks some essential amino acids. Pasta also contains 11–15% proteins but is deficient in lysine and threonine, common to most cereal products [4]. Vegans who do not consume animal protein will face a huge problem of getting essential amino acid lysine. Legume proteins are relatively low in Sulphur-containing amino acids, methionine, cysteine and tryptophan, but high in lysine.

Consequently, legumes and cereals are nutritionally complementary [5], where together provide the essential amino acid profile for vegans. Legume flours can partially substitute durum wheat semolina in pasta. However, depending on the substitution level, the pasta making process could be difficult. The inclusion of pulses in cereal based foods is known to increase the nutritive value by improving protein content and lysine availability. So, the objective of this study is to substitute semolina with pulse flour and develop protein rich pasta.

II. MATERIAL & METHODS

Based on the literature [6] and according to availability, affordability & consumption patterns of the Sri Lankans, mung & soy pulses were selected to enrich the pasta.

A. Collection & Preparation of the Raw Materials

Commercial wheat semolina & mung were purchase from the supermarket. Soy beans were purchased from the Pettah market.

Mung flour preparation - Mung beans were cleaned to remove all contaminant and then roasted in an open pan at approximately 160°C for 15 minutes and then cooled and grinding.

Soybean flour preparation - The soybeans were cleaned to remove all contaminants and then were steeped in water at room temperature (30 ± 2°C) for one hour. The beans were then drained and spread to dry in the cabinet oven heating at 99°C for 25 min. and then ground.

B. Proximate Analysis

Protein content of each raw material was estimated using kjeldhal method.
C. Sample preparation

Five samples were prepared using wheat flour and two other pulses in different proportions.

According to the results of protein analysis, samples were formulated considering the current local regulations to produce high protein pasta product.

As per the Food Labelling and Advertising Regulation - 2005, any food shall state or indicate thereon that such food is a source of protein unless, the quantity that would reasonably be expected to be consumed in one day contributes at least 12g of protein, at least 20% of the energy value of the food is provided by protein. Considering the regulations and the protein content of the raw materials, minimum amount of protein content that should maintain in the new product is 15% (Serving size of the pasta = 80g (Average)).

D. Pasta preparation

Semolina and pulses samples at different levels were prepared according to the Table II. Samples with 1% of salt were mixed with optimum amount of water and mixed until form dough. The dough was kneaded for about 10 - 15 minutes, until the dough was soft and pliable. Dough was sprinkled lightly with flour and wrapped loosely with plastic wrap. Dough was rest at room temperature for 20-30 minutes.

Pasta machine was set up, and then the dial was turned to the widest setting. Dough was feed through the rollers. Folding and rolling technique was used on the widest setting. Dough was feed through the machine. Kept reducing the settings until the dough was rolled as thinly as necessary (Until 4th setting). Pasta dough was rolled through the machine. Finished pasta was kept on a drying tray. Pasta samples were cooked separately in a stainless-steel pan. In each case, 50g pasta sample was taken and cooked in 500 ml of water. The cooking temperature was maintained at 98-100°C throughout the cooking process. Cooked pasta was then drained, cooled to room temperature and used for sensory evaluation. Each of the samples was randomly numbered using a three-digit code. Panelists were asked to indicate their preference on a 5-point hedonic scale with the degree of liking: 1 = Dislike very much to 5 = Like very much.

F. Proximate analysis of samples

All five samples were tested for following proximate composition using reference methods,

III. RESULTS & DISCUSSION

The overall acceptability (OAA) of cooked pasta with in the combinations varied from 1.8 to 4.1. Statistical analysis states that there is a significant difference among the all cooked pasta samples at 0.05 significant levels. OAA decreased by increasing the proportion of mung flour. This is may be due to unattractive dark color and raw flavor of mung beans which limits wide acceptability of its food products.

E. Determine the sensory acceptability of the prepared pasta samples

Rating test was conducted for each sample to analyses the organoleptic factors (color, odor, texture, mouth feel, taste & overall acceptance) affecting the acceptability of the product. Used semi trained panel of 30 members. Each pasta samples were cooked separately in a stainless-steel pan. In each case, 50g pasta sample was taken and cooked in 500 ml of water. The cooking temperature was maintained at 98-100°C throughout the cooking process. Cooked pasta was then drained, cooled to room temperature and used for sensory evaluation. Each of the samples was randomly numbered using a three-digit code. Panelists were asked to indicate their preference on a 5-point hedonic scale with the degree of liking: 1 = Dislike very much to 5 = Like very much.

F. Proximate analysis of samples

All five samples were tested for following proximate composition using reference methods,

III. RESULTS & DISCUSSION

The overall acceptability (OAA) of cooked pasta with in the combinations varied from 1.8 to 4.1. Statistical analysis states that there is a significant difference among the all cooked pasta samples at 0.05 significant levels. OAA decreased by increasing the proportion of mung flour. This is may be due to unattractive dark color and raw flavor of mung beans which limits wide acceptability of its food products.

E. Determine the sensory acceptability of the prepared pasta samples

Rating test was conducted for each sample to analyses the organoleptic factors (color, odor, texture, mouth feel, taste & overall acceptance) affecting the acceptability of the product. Used semi trained panel of 30 members. Each pasta samples were cooked separately in a stainless-steel pan. In each case, 50g pasta sample was taken and cooked in 500 ml of water. The cooking temperature was maintained at 98-100°C throughout the cooking process. Cooked pasta was then drained, cooled to room temperature and used for sensory evaluation. Each of the samples was randomly numbered using a three-digit code. Panelists were asked to indicate their preference on a 5-point hedonic scale with the degree of liking: 1 = Dislike very much to 5 = Like very much.

F. Proximate analysis of samples

All five samples were tested for following proximate composition using reference methods,

III. RESULTS & DISCUSSION

The overall acceptability (OAA) of cooked pasta with in the combinations varied from 1.8 to 4.1. Statistical analysis states that there is a significant difference among the all cooked pasta samples at 0.05 significant levels. OAA decreased by increasing the proportion of mung flour. This is may be due to unattractive dark color and raw flavor of mung beans which limits wide acceptability of its food products.

E. Determine the sensory acceptability of the prepared pasta samples

Rating test was conducted for each sample to analyses the organoleptic factors (color, odor, texture, mouth feel, taste & overall acceptance) affecting the acceptability of the product. Used semi trained panel of 30 members. Each pasta samples were cooked separately in a stainless-steel pan. In each case, 50g pasta sample was taken and cooked in 500 ml of water. The cooking temperature was maintained at 98-100°C throughout the cooking process. Cooked pasta was then drained, cooled to room temperature and used for sensory evaluation. Each of the samples was randomly numbered using a three-digit code. Panelists were asked to indicate their preference on a 5-point hedonic scale with the degree of liking: 1 = Dislike very much to 5 = Like very much.

F. Proximate analysis of samples

All five samples were tested for following proximate composition using reference methods,
varied from 61.40 to 64.90 as shown in the Table V. According to the statistical analysis there is a significant difference in color among the all cooked pasta samples at 0.05 significant levels. Highest L* value was observed with control and addition of pulses has decreased the brightness. This difference in color is due to polyphenolic pigments present in pericarp, aleuronic layer and in endosperm region of pulses [8].

According to color measurements and evaluations of the panelists, adding pulses has an influence on the color of the pasta. As expected, an increase in darkness (L*) in the color of enriched pasta products was observed compared to control, because of the pigments present in the pulses. Soya bean seeds contain high carotenoid content, major one is Lutein [9], this is the main reason for the high b* value in the formulations (F1, F2 & F3) where has high soya flour percentage. Lowering of a* value is observed with the increasing of the mung bean flour due to the green/brown coloration.

Odor and taste of the all cooked pasta samples are significantly differed at 0.05 significant levels, which indicate positive effect of different combination of pulses in the pasta semolina replacement.

Friedman analysis results shows the significant different of the overall acceptance among the five pasta samples at 0.05 significant level. But according to the descriptive analysis, F1 sample shows the highest mean score for the overall acceptance hence it is the most accepted sample.

Fortification of pasta with pulses significantly increases the protein, fat and fiber content of final product, whereas carbohydrate content of prepared pulse pasta decreased in comparison to control pasta. The results are shown in Table VI. Pulse sources used for formulation of pasta were rich in protein. Among legume, soya possessed highest protein.

According to the Sri Lankan food regulations, minimum amount of protein content that should maintain in the new product to indicate that such food is a source of protein is 15%. So, the all formulations were prepared to comply with the regulation. Pulses incorporated dough were little fragile at the roller specially the mung incorporated dough got cracked while rolling. This is mainly because of the low gluten content of the dough and high fiber content of the mung flour, which creates under development of gluten network. Soya beans has the highest mineral content [10] whereas resulted high ash content in the formulations which have high amount of soya flour. Comparatively pulse enriched pasta has higher fiber content and the content increased when the mung flour proportion is increasing.

Optimum Cooking time of pasta sample was significantly increased as compare to the control sample, in each case 50g of each sample was taken and cooked separately for the evaluation of cooking time. The optimum cooking time (OCT) was evaluated according to the AACC approved method 66-50. The results are shown in Table VII.

<p>| TABLE VI: PROXIMATE COMPOSITION OF PASTA SAMPLES |</p>
<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture %</th>
<th>Ash value%</th>
<th>Carbohydrate%</th>
<th>Protein%</th>
<th>Fiber%</th>
<th>Fat%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>75.22±0.08</td>
<td>1.07±0.06</td>
<td>14.34±0.44</td>
<td>11.56±0.28</td>
<td>3.81±0.05</td>
<td>0.90±0.01</td>
</tr>
<tr>
<td>F1</td>
<td>64.90±0.19</td>
<td>4.86±0.09</td>
<td>26.46±0.23</td>
<td>20.68±0.05</td>
<td>5.91±0.01</td>
<td>4.41±0.02</td>
</tr>
<tr>
<td>F2</td>
<td>62.37±0.38</td>
<td>3.77±0.45</td>
<td>24.46±0.14</td>
<td>20.08±0.01</td>
<td>6.63±0.04</td>
<td>3.97±0.00</td>
</tr>
<tr>
<td>F3</td>
<td>61.40±0.01</td>
<td>2.29±0.26</td>
<td>21.85±0.05</td>
<td>19.23±0.44</td>
<td>7.31±0.02</td>
<td>2.29±0.01</td>
</tr>
<tr>
<td>F4</td>
<td>63.65±0.09</td>
<td>2.02±0.37</td>
<td>15.87±0.06</td>
<td>18.52±0.19</td>
<td>8.02±0.04</td>
<td>2.52±0.01</td>
</tr>
<tr>
<td>F5</td>
<td>63.80±0.02</td>
<td>1.76±0.02</td>
<td>16.00±0.03</td>
<td>11.56±0.28</td>
<td>3.81±0.05</td>
<td>0.90±0.01</td>
</tr>
</tbody>
</table>

Supplementation of legume flours (soybean and mung bean) has enhanced the cooking quality of pasta significantly. Legumes supplementation had increased the minimum cooking time of the resulted pasta as compared to control. During pasta cooking, there is competition between starch and protein for water. When less protein surrounds starch granules, they swell and gelatinize faster and results more amylase leaching to the cooking solution [11]. The literature reported a decrease in OCT pasta at increasing level of semolina substitution with inulin, durum bran and bean flour [12]. Similar studies [13] reported that legume supplementation (cowpea, mung bean, pigeon pea) has increased the minimum cooking time compared to control and also [14] got the similar results where pulse incorporated pasta shows increased cooking time compared to control and decrease with the increasing of mung content in the formulation.

The major challenges in using soybean flour in food are the elimination of anti-nutrients, oligosaccharides, and beany flavor. Soaking and roasting of soy beans have been applied to meet these objectives [15]. Roasting for 20 min at 100°C was reported to inhibit 90% of trypsin inhibitors activity in soybean flour. In current experiment soybean has roasted for 25 min at 99°C and the denaturation temperature of soy protein is higher than 100°C [16], so assumed no protein denaturation during roasting of the soya bean. It has been reported that the application of roasting achieved a pleasant flavor in soy bean [17]. Reference [11] reported that roasting induced a greater increase in protein digestibility of soybean than fermentation, also reference [18] reported increased antioxidant activity and in vitro protein digestibility in roasted soy flour [18]. In traditional households, the beans are soaked for 1–3 days, during which some microbial activities are activated, leading to improvement of the nutritional quality of the resulting flour. Recent investigations revealed a positive effect of long-time soaking in reducing the anti-nutrients and the viscosity of maize flour, but this varied with soaking time. But soaking for too long hours will decrease the protein availability, specially the soluble protein fraction.
ACKNOWLEDGMENT

R. N. Balasooriya thanks staff members of the Department of Food Science & Technology, Faculty of Applied Sciences in University of Sri Jayewardenepura, Sri Lanka.

REFERENCES


B. P. R. N. Balasooriya is born in Sri Lanka, 1990/01/19. Holds a Bachelor’s degree in Food Science and Nutrition, specialized in Food Science and Technology from Wayamba University, Kuliapitiya, Sri Lanka, 2015 and a Master’s Degree in Food Science and Technology from University of Sri Jayewardenepura, Nugegoda, Sri Lanka, 2018. She worked as a QUALITY ASSURANCE EXECUTIVE at Maliban Biscuit Manufacturers (Pvt.) Ltd., PRODUCT DEVELOPMENT EXECUTIVE at AB Mauri Lanka (Pvt.) Ltd. And currently working at Fonterra Brands Lanka (Pvt.) Ltd as a MANAGEMENT TRAINEE (RESEARCH AND DEVELOPMENT). Previously worked on a research at Tea Research Institute, Sri Lanka on the Comparative Analysis on Quality Characteristics of Commercially Available Green Tea in Sri Lanka. Miss Balasooriya awarded a gold medal for Food Chemistry and Chemistry for her degree in Food Science and Nutrition.

DOI: http://dx.doi.org/10.24018/ejers.998.3.12.998