

SENSORY AND NUTRITIONAL ATTRIBUTES OF SAUSAGES DEVELOPED WITH SPROUTED LOW AMYLOSE RICE VARIETIES

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ABSTRACT

Absorbing the country's excess rice production towards convenient foods which consists of high fiber and low fat will benefit the rice producers as well as the health conscious consumers. Sprouted low amylose rice variety (At 405) was cooked and mixed with steamed oyster mushroom and other ingredients (black pepper, garlic, sugar, iodide salt and soya oil) to the ratio of 64:25:11 (T₁). Semi trained sensory panel (25 <) evaluated the T₁ of experiment 1 on their appearance, cross sectional appearance (CSA), aroma and taste through five point hedonic scale. Based on the results, cooked rice was replaced by rice powder in experiment 2. In experiment 3, variety At 309 was included and compared with At 405 cooked rice and powdered rice together. To improve the compact filling of sausage, corn flour was introduced additionally in experiment 4. Based on the sensory scores a ranking test was established in experiment 5 to select the best treatment. Nutritional status and the safe storage ability of the selected treatments were also studied. At 309 a low - intermediate amylose variety had low sensory scores compared to At 405. Highly ranked sausages consist of cooked rice: mushroom: other ingredients to the ratio of 64:25:11 and rice: rice powder: mushroom: other ingredients to the ratio of 32: 32: 25: 11, respectively. Experienced difficulty in improving the compact filling of sausages to obtain desirable CSA was the major drawback. Although successive results on improved CSA were gained by incorporating corn flour to the recipe, the taste scores were significantly less. Developed products contain more fibre compared to chicken sausages available in the market, and less fat which were considered favourably. Sprouted rice sausages stored under -18 °C for 8 weeks in polyethylene pouches were safe on microbial levels. Variety At 405, could be used to produce sprouted rice sausages with acceptable taste and further improvement in compact filling is required.

KEYWORDS: Low amylose, Rice sausages, Nutritional attributes, Sensory evaluation.

INTRODUCTION

Sri Lanka has reached self sufficiency in rice by the year 2010, and the rice production in 2013 was 4.7 million tons (DCS, 2014). Approximately 0.3 million tons of paddy was in excess. Promoting the consumption of rice based products and introducing new rice based products will enhance the utilization of excess rice production in the country. Development of rice products with high fibre and less fat will be useful as the concerns on healthy and safe diets are given priority nowadays. Sprouted brown rice comprise of more fibre than milled rice where sprouting increases many of the grain's key nutrients, such as vitamins B and C, folate, fibre, and essential amino acids (Shoichi and Yukihiro, 2004). Sprouted brown rice (SBR) has potential to become innovative rice

by preserving all nutrients in the rice grain for human consumption in order to create the highest value from rice (Patil *et al.*, 2011). Therefore, including sprouted rice on rice products will ultimately enhance the nutrition level and benefit the health conscious consumers.

Sausage is a convenient food available in a great number of varieties and flavours. It serves as a quick and easy meal and also fit conveniently into humans modern lifestyles as an elegant taster for entertaining. More or less sausage was originally deliberated as using and preserving animal meat. It usually consists of ground meat, mixed spices and salt stuffed into a casing (Azham, 2011). It is well known thing that meat contains cholesterol and a higher proportion of fat. Increased ratio of fat in food can lead to suppressive effects on the pathogenesis of many diseases (Azham, 2011).

The thought of producing sausages out of sprouted rice will open novel path for promoting rice products for the health conscious consumers. As an alternative to chicken based sausages, development of rice based sausages have been studied using glutinous rice and oyster mushroom and experimented (Chockchaisawasdee *et al.*, 2010). Glutinous rice contains zero percent of amylose. Glutinous rice is sticky when served as cooked rice and not available locally. Similar local sticky rice varieties At 405 and At 309 are of low amylose (Hafeel, 2011) and low–intermediate amylose (Pathinayake, 2013). Oyster mushroom could be included with low amylose (< 20% amylose) rice to produce sensorily acceptable sausage (Hafeel *et al.*, 2014). The aim of the study was to find out the possibility of producing sensorily acceptable rice sausages with sprouted low amylose rice varieties which will provide health benefits as a high fibre and low fat convenient food.

MATERIAL AND METHODS

Experiment 1

One kilogram of paddy was passed twice through a laboratory rubber roll sheller (Model; THU 035, Satake, Japan) for husking to obtain brown rice. Undamaged brown rice grains obtained from paddy were well washed and soaked in distilled water for 2 hours. Water was drained off and allowed for germination for 10 hours (Hafeel *et al.*, 2014). One cup of sprouted rice sample was washed and cooked in a 300 ml mini rice cooker (Model: Panasonic, Japan) with 1½ cup of water. Once the cooker was automatically switched off, cooked rice sample was blended to obtain the rice paste and 64 g of rice paste were measured.

Oyster mushrooms were well also washed and chopped into small pieces. These small pieces of mushroom were steamed at 100 °C for 20 minutes (Chockchaisawasdee *et al.*, 2010). Steamed mushroom was placed on a clean dry cloth and squeezed to remove water and then blended to obtain a paste (25 g). Cleaned and washed fresh garlic was chopped and blended to obtain garlic paste (2 g). Clean black pepper seeds were powdered in a grinder to obtain powder (1.5 g). Sugar (1.5 g), iodide salt (1 g), and soya oil (5 g) were measured accurately. All these ingredients which had given acceptable sensory quality attributes (Hafeel *et al.*, 2014) were mixed thoroughly in a blender to obtain a uniform paste. Then this mixture (T₁) was filled into 8 cm long non edible collagen casing with a cake nozzle.

Sausage samples were kept in ambient temperature until they reach the pH of 5 ± 0.2 (Chockchaisawasdee *et al.*, 2010). Samples packed in polyethylene (LDPE) pouches were kept in the freezer below -18 °C (Chockchaisawasdee *et al.*, 2010) to avoid further fermentation. After 5 days sausages with improved binding ability (Hafeel *et al.*, 2014) were drawn out of freezer. Panel evaluated the appearance, cross sectional appearance (CSA) and taste through 5 point hedonic scale.

Selected samples were shallow fried with 30 ml of soya cooking oil in a non-stick frying pan (15 cm diameter) and served for the 25 panellists for sensory evaluation (Figure 1). Panellists scored for each attribute at 1-5 scores, where 1-5 denotes dislike very much, dislike, neither like non dislike, like and like very much, respectively. Based on the results of experiment 1, to improve texture and filling property new batch of sausage were planned.

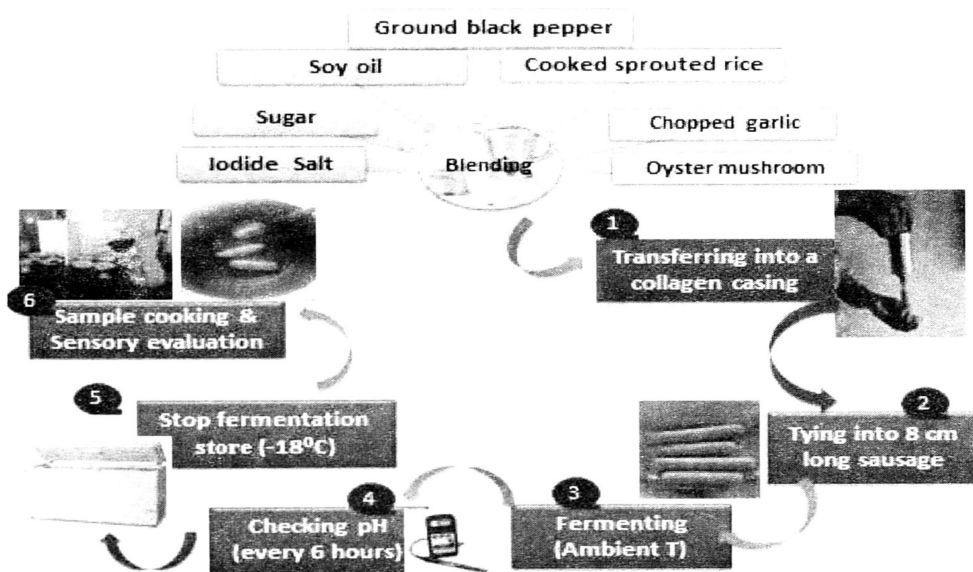


Figure 1. Flow diagram on production of low amylose rice sausage.

Experiment 2

To improve the compact filling of sausage, 64 g of sprouted rice flour of the same variety was included on behalf of cooked rice paste and tested as a different treatment (T₂). Following the preparation method given in Figure 1, the sausages were prepared and offered to 25 member sensory panellists to evaluate for CSA and taste according to the 5 point hedonic scale as describe earlier.

Experiment 3

After considering the results of experiment 2, to improve the filling property and the taste together a mix of cooked rice paste and rice powder were included to treatments and a new set of low amylose sprouted rice sausages were made according to Table 1 and Figure 1.

Table 1. Ingredients used to prepare different sprouted rice sausages in experiment 3.

Ingredients	Quantity(g)			
	T ₁	T ₃	T ₄	T ₅
Sprouted cooked rice	64.0	32.0	64.0	32.0
Oyster mushroom	25.0	25.0	25.0	25.0
Garlic paste	2.0	2.0	2.0	2.0
Black pepper powder	1.5	1.5	1.5	1.5
Sugar	1.5	1.5	1.5	1.5
Iodide Salt powder	1.0	1.0	1.0	1.0
Soya oil	5.0	5.0	5.0	5.0
Sprouted rice powder		32.0		32.0

Note: T₁ and T₂ used At 405 where as T₄ and T₅ used At 309

To overcome the practical difficulties experienced during the preparation of the cooked rice paste, At 309 a less sticky variety (low to intermediate amylose) compared to At 405 was introduced. At 309 highly aromatic/scented and offers 40% more yield compared to At 405. Thirty member panellists evaluated the samples for aroma, taste and CSA though 5 point hedonic scale.

Experiment 4

Based on the results obtained in experiment 3, the same two varieties were considered to prepare sausages including corn flour. Corn flour consists of good water holding capacity and therefore it is included in the recipe to improve taste and filling property. CRA (2006) revealed that corn flour has the ability of thickening the aqueous

system and forms a paste. It also provides strong adhesive films when spread on smooth surfaces and dried. Accordingly new batch of sausages T₆ and T₇ were prepared and compared with T₃ and T₅ (Table 2). Twenty four member sensory panels evaluated the treatments through ranking test.

Table 2. Ingredients used to prepare different sprouted rice sausages in experiment 4.

Ingredients	Quantity (g)			
	T ₃	T ₆	T ₅	T ₇
Sprouted cooked rice	32.0	32.0	32.0	32.0
Oyster mushroom	25.0	25.0	25.0	25.0
Garlic paste	2.0	2.0	2.0	2.0
Black pepper powder	1.5	1.5	1.5	1.5
Sugar	1.5	1.5	1.5	1.5
Iodide salt powder	1.0	1.0	1.0	1.0
Soya oil	5.0	5.0	5.0	5.0
Sprouted rice powder	32.0	16.0	32.0	16.0
Corn flour		16.0		16.0

Note: T₃ and T₆ used At 405 where as T₅ and T₇ used At 309

Experiment 5

Considering all the above treatments developed with low amylose sprouted variety At 405 (Table 3) were again ranked by 25 panellists on sensory preference for CSA, aroma and taste according to ranking test (Meilgaard, 2007).

Table 3. Ingredients and quantities used to prepare different sprouted rice sausages.

Ingredients	Quantity (g)		
	T ₁	T ₂	T ₃
Sprouted cooked rice <i>At 405</i>	64.0		32.0
Oyster mushroom	25.0	25.0	25.0
Garlic paste	2.0	2.0	2.0
Black pepper powder	1.5	1.5	1.5
Sugar	1.5	1.5	1.5
Iodide salt powder	1.0	1.0	1.0
Soya oil	5.0	5.0	5.0
Sprouted rice powder <i>At 405</i>		64.0	32.0

Nutritional analysis

Proximate compositions of the sensorily best two samples were analyzed and compared with chicken sausage available in the market (AOAC, 2000). Moisture,

protein, fibre, fat, ash, and carbohydrate contents of 3 samples drawn out of each treatment were determined.

Packaging and Storage

Replicated samples of selected sausage treatments were packed in low density polyethylene (LDPE) pouches (gauge 300) separately. Then stored for 8 weeks in a deep freezer (-18 °C) and evaluated for moisture, pH and microbiological properties at 3 and 8 weeks of storage.

Determination of the pH values

The pH meter (DIN ENISO 8655-6) was calibrated at pH 4 and pH 7 solutions. Five grams of soup sample was added into a beaker containing 50 ml of distilled water and stirred well. The pH values of prepared samples were recorded in replicates at 28 °C.

Microbiological analysis of low amylose sprouted rice sausages

Plate count agar (PCA) and potato dextrose agar (PDA) standard media were prepared and used to obtain the total plate count and mold and yeast counts, respectively. Standard laboratory measures were taken throughout the study to avoid contamination (AOAC, 2000). Microbial determination was done and mean values of colony forming units (CFU) were expressed according to Hafeel *et al.* (2013).

RESULTS AND DISCUSSION

Experiment 1

According to the sensory results none of the panellists disliked the product (T₁) on appearance, aroma and taste. Ninety six percent of them liked the appearance and of which 20% T₁ very much. Only 4% neither liked nor disliked its appearance. Eight percent of the panellists neither liked nor disliked the cross sectional appearance of the product. However, 92% disliked it mainly due the drawbacks found in compact filling. Therefore, ingredients which will enhance the compact filling are recommended to be included to T₁ recipe and further evaluate. Ninety two percent of the panellists scored like and very much like on taste.

Experiment 2

In this experiment, Panellists have scored contrastingly compared to experiment 1. Appearance and taste of rice powder sausages (T_2) were disliked by 16% of the panellists. Seventy percent disliked the cross sectional appearance of T_2 . Although John *et al.*, 2004 have stated the promotion of food powders to create sustainable network in the area of food powders, inclusion of sprouted rice powder has not improved the compactness in filling. Therefore, in order to improve the filling property low-intermediate amylose variety (At 309) was recommended to be included and studied. In addition, treatments with sprouted cooked rice and both sprouted cooked rice and sprouted rice flour also recommended to be studied for sensory attributes.

Experiment 3

T_1 had significantly ($p \leq 0.05$) higher score on cross sectional appearance (CSA) than T_4 and T_5 , except T_3 (Figure 2A). Introduced variety At 309 has not contributed to improve the compact filing of sausage. Sausages made with At 405 has given better appearance even with cooked rice or cooked and powdered rice together. None of the treatments differed significantly ($p \leq 0.05$) on aroma. In all four treatments, except rice (cooked rice or rice powder) other ingredients were same in quantity. Therefore, there was no influence by any of the treatment on sausage aroma. Variety difference or added forms of it did not show any influence on aroma.

T_1 scored the highest on taste than T_5 and no significant differences between other treatment combinations. T_1 and T_3 had similar sensory scores and both were prepared with At 405. Although T_1 recorded comparatively more scores on CSA, according to Figure 2, it is to be improved. Therefore, T_3 which performed equal to T_1 and with rice powder is recommended to be considered for further improving by adding corn flour. Corn flour consists of good water holding capacity and therefore, it could be included in the recipe to improve taste and filling property (CRA, 2006).

Experiment 4

T_6 and T_7 recorded significantly higher CSA scores than T_3 and T_5 , respectively (Figure 2B). This proves the influence of corn flour on the improvement of compact filling of the sausages significantly. However, there were no differences between treatments on aroma. T_3 gave the highest significant taste score among all. Sausage made of variety At 405 has got higher taste scores compared to sausages made of At 309

similar to the experiment 3. Based on taste scores sausages made of At 405 with cooked rice, powdered rice and both were recommended to be compared.

Experiment 5

Cross sectional appearance was ranked first on T₂ and no significant difference between T₁ and T₃. Contrastingly T₂ was given lowest scores on aroma and taste compared to other two treatments. Therefore, sausages produced with variety At 405 could be recommended to prepare with 64 % of cooked rice or 32 % of cooked and powdered rice together. However, the developed product has to be improved further on compact filing.

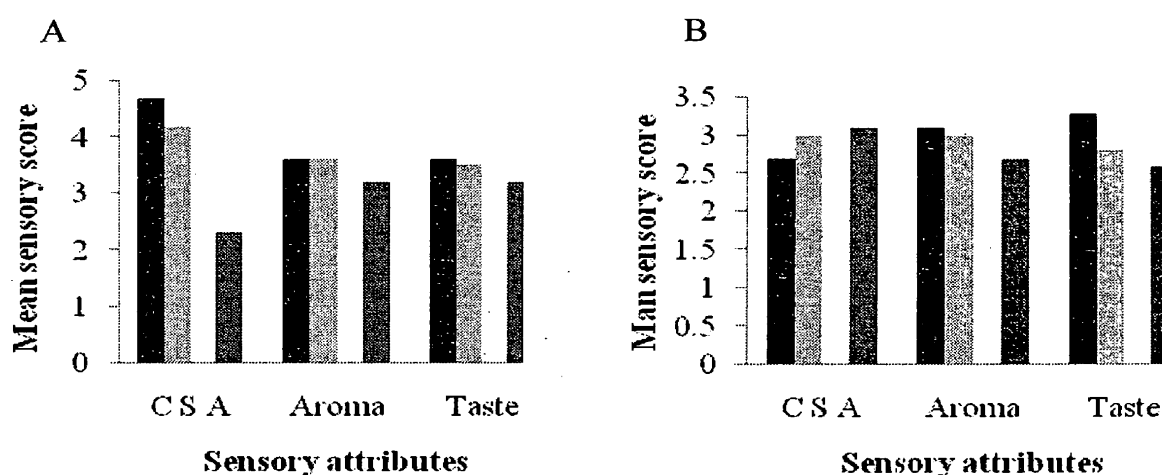


Figure 2. Sensory scores on CSA, aroma and taste of different sausage treatments.

Note: (A) Experiment 3 : ■T₁, ▨T₃ □T₄, ▩T₅

(B) Experiment 4 : ■T₃, ▨T₆, □T₅, ▩T₇

Nutritional status of sausages.

T₁ which comprised of cooked rice recorded significantly more moisture compared to T₃ (Table 4). But compared to chicken sausage it was less. Protein, fat and ash contents were also significantly high in chicken sausage compared to the two rice sausages. A study done by Azahm (2011), obtained protein, fat and ash within a range of 4.4-5.2%, 0.3-3.7 % and 3.2-4.7% respectively in vegetarian sausage made of mainly oyster mushroom, palm based cheese and chickpeas. However, fibre contents were more than 25 and 22 times high in, T₁ and T₃ (rice sausages), respectively compared to chicken sausages. Food with high fibre offer more health benefits than oily food. However, lower fibre contents of 5.23% to 6.64% have been reported by Azahm (2011) in vegetarian sausage. The vegetarian sausage made of rice and mushroom had half times less fat content compared to chicken sausages.

The pH status.

The pH, of rice sausages was stable around 5 ± 0.2 even after 8 weeks. This shows that product could be stored safely under $-18\text{ }^{\circ}\text{C}$ for more than 8 weeks in polyethylene pouches.

Table 4. Nutritional compositions of T₁, T₂ and chicken sausage.

Sausage treatment	Moisture %	Protein %	Fat %	Ash %	Fiber %
T ₁	10.27b	3.74c	3.50c	1.20b	8.80a
T ₃	8.90c	4.58b	5.50b	0.80c	7.95b
Chicken sausage	13.07a	12.07a	11.00a	1.87a	0.35c

Note: T₁=Cooked sprouted rice (At 405), Oyster mushroom and other ingredients; T₃=Cooked sprouted rice (At 405), Sprouted rice powder (At 405), Oyster mushroom and other ingredients.

Microbiological status in low amylose sprouted rice sausages

SLS standard level for total plate count and yeast and mold count for sausages are $<10^6$ CFU/g and $<1 \times 10^4$ CFU/g, respectively. According to Table 5, the CFU/g at 3 and 8 weeks were below the safe limit. Therefore, rice sausages could be considered for safe consumption even after 8 weeks of frozen storage.

Table 5. Microbial count of sausages packed in polyethylene pouches and stored for 3 and 8 weeks at -18°C .

Sample	Total plate count (CFU/g)			Yeast and mold count (CFU/g)		
	Initial	3 rd week	8 th week	Initial	3 rd week	8 th week
T ₁	7.8×10^1	23.5×10^1	36.3×10^1	0.6×10^1	1.8×10^1	2.8×10^1
T ₃	7.5×10^1	22.9×10^1	34.7×10^1	0.6×10^1	1.7×10^1	2.7×10^1

Note: CFU=Colony forming units.

CONCLUSIONS

Sprouted low amylose rice (At 405) could be considered successfully in developing sausages with acceptable sensory attributes. Among many evaluated treatments, sausages developed with cooked At 405 rice ranked the best in taste. High sensory scores were given to T₁, and T₃ over their sensory attributes which had sprouted cooked rice: oyster mushroom: other ingredients to the ratio of 64:25:11 and sprouted cooked rice: sprouted rice powder: oyster mushroom: other ingredients to the ratio of 32: 32: 25: 11. Although At 309 a low - intermediate amylose variety was introduced in developing sausages, the sensory scores were less compared to sausages of At 405. The

major difficulty was the drawback experienced in improving the compact filling of sausages to obtain desirable CSA (cross sectional appearance). Although successive results on improved CSA were gained by incorporating corn flour to the recipe, the taste scores were less comparatively. Developed products contain higher amounts of fibre compared to chicken sausages available in the market and comparatively low fat contents. Sprouted rice could be stored safely under -18°C for 8 weeks in polyethylene pouches.

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