

Nutritional and Sensory Qualities of Palmyrah (*Borassus Flabellifer.L*) Odial Based Snack Foods

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Abstract

A research was conducted to develop nutritionally value added products with palmyrah odial to be used as snack foods and select the best among them by evaluating their nutritional and organoleptic characteristics. In this busy world, people have lack of time to prepare their meal. As quick and easy meal ideas are important to master, ready to serve meals have achieved an unbreakable place in the market. Therefore, a research was carried out to make ready to serve snack foods such as flakes, dried pellets and Ready To Serve (RTS) cereal powder using the locally produced odial for make it as more palatable and to increase its consumption.

Twelve types of different mixtures were produced using boiled dried palmyrah tuber, rice, maize, sorghum, soybean, green gram, black gram and sugar. By adding different proportions of odial flour, varieties of mixtures were produced. Also by changing the amount and the combination of the cereals, the differences were created among the treatments. Nutritional and sensory attributes of the twelve developed cereal mixtures were evaluated to select the best among them and some kinds of snack foods were developed from the best mixture, T₇. The nutritional as well as sensory values of snack foods and the

base mixture were evaluated to select the best product. The findings of this study revealed that the developed products are not significantly differed in their nutritional attributes. Cereal mix wet pellets prepared from the basic mixture and RTS cereal powder are the best products considering their sensory quality attributes.

Key words: *Nutritional analysis, palmyrah odial, sensory analysis, value added products*

Introduction

Food is the main source of nourishment for human body. However people have lack of time to prepare their meal; therefore most people prefer snack foods as their breakfast meal. Because of that, ready to serve meals have achieved an unbreakable place in the food market, as quick and easy meal ideas are important to master. These facts show some possibilities for snack foods to succeed in food marketing.

Nutritionists generally recommended that breakfast should provide one fourth to one third of the daily-recommended intake of essential nutrients. Cereals are the most concentrated and cheapest source of food energy known (Harrel and Dirks, 1998). Meals made with cereals had higher contents of all vitamins and minerals than did meal included no cereal (Morgan *et al*, 1981). According to Gibson and O'Sullivan (1995), children who eat breakfast cereals tend to have more desirable daily nutrient intakes than those who do not. Therefore, need for the development of energy rich snack foods using cereals had been recognized.

The total palmyrah population in Sri Lanka is about eleven million (Palmyrah Development Board, 2004). The potential yield of flour is around 5000 metric tones of flour per year. The gross composition and mineral composition of odial flour (dried palmyra tuber) compares favorably with other staple foods (Mohanajeyaluxmi, 1986). In Sri Lanka, odial pittu, palmyrah soup, thosai mix, biscuits, palm laddu and jaggery aluva are now produced from odial flour. As only a small quantity of odial is used for the already described food items, it is advisable to diversify and make other starch based products (Theivendirarajah, 1991). To increase the consumption of odial there is a need to produce

value added products from that also it has to be made as more palatable, since it is less palatable. Substitution of odial flour in snack foods, for other normally used flour up to a certain level could earn some foreign exchange. The components found in this tuber might improve the quality of snack foods.

Protein energy malnutrition is the common nutritional disorder found in Sri Lanka. Even if protein consumption has an important role in our daily meal, many of the people ignore that due to its higher cost. There are the possibilities for the production of low cost foods, based on the complementation of the protein qualities between legumes and cereals (Vijayaraghavan and Rao, 1976). Therefore placing the legumes in the cereal-based diet may provide a complete protein rich diet. Hence, a balanced protenacious diet can be formulated by combining cereals with legumes. Kordylas (1990) suggested that 30-40% of pulses could be used to produce a high protein breakfast meal; therefore pulses of 39% were used in the production. Thus the pulses green gram, black gram and soybean were used in the production. Therefore, a study was carried out to develop consumer preferable, nutritious and ready to serve snack foods from locally produced agricultural products and to evaluate their nutritional and sensory attributes.

Materials and Methods

Basic Mixture Development

Boiled dried palmyrah tuber, rice, maize, sorghum, soybean, green gram, black gram and sugar were used as raw materials for developing basic mixtures. Twelve different types of blends were prepared from the raw materials. Black gram flour of 12%, green gram flour of 20% and soybean flour of 7% were added as protein sources for each blend based on the standard nutritional requirements. Cane sugar of 23% also added to each blend for sweetening purpose. By adding different proportions of odial flour, varieties of basic mixtures were produced. Also by changing the amount and the combination of the cereals the differences were created among the treatments.

Table 1: Description of the Treatments

Mixture of cereals	Amount of Odial Flour used			
	5%	10%	15%	20%
Maize and rice	T ₁	T ₄	T ₇	T ₁₀
Maize and sorghum	T ₂	T ₅	T ₈	T ₁₁
Rice and sorghum	T ₃	T ₆	T ₉	T ₁₂

Basic mixtures of T₁, T₄, T₇ and T₁₀ were produced using maize, rice combinations; T₂, T₅, T₈ and T₁₁ were produced using maize, sorghum combinations; and T₃, T₆, T₉ and T₁₂ were produced using rice, sorghum combinations. By adding 5%, 10%, 15% and 20% of odial flour with the protein sources different combinations of cereal mixes were produced. The remain portion was completed by adding mixture of cereals. Mixture of T₁, T₂ and T₃ were produced by adding 5% odial flour; T₄, T₅ and T₆ were produced by adding 10% odial flour; T₇, T₈ and T₉ were produced by adding 15% odial flour; T₁₀, T₁₁ and T₁₂ were produced by adding 20% odial flour.

Nutritional Quality of Basic Mixtures

The nutritional attributes such as moisture, ash, fat, protein, fiber and soluble carbohydrate of the developed blends were analyzed using routine AOAC (1998) methods of analysis. Moisture content of the product was determined by gravimetric method. The ash content was estimated by igniting the sample at 500-550°C using muffle furnaces. Fat is determined by subjection of developed sample to continuous extraction with petroleum ether for six hours. Protein content of the developed products was analyzed by Kjeldhal method. The fiber content was determined by igniting the sample using muffle furnace after boiling the sample in acid and base solutions. Soluble carbohydrate% was calculated by subtracting the amount of moisture, ash, fat, protein and fiber content from 100.

Sensory Characteristics of Basic Mixtures

Sensory evaluation was carried out in two steps. In this analysis the sensory characteristics such as taste, flavour, colour, texture, mouth feel and overall eating quality of the developed blends were evaluated.

In initial step, six kinds of basic mixtures were selected for further analysis. The best six kinds of treatments which were selected through nutritional analysis and initial sensory analysis were subjected to the final sensory analysis, to obtain accurate results. Coconut milk was prepared by mixing the coconut powder in hot water. A volume of 25ml of coconut milk was added with 100g of each developed blend and they were mixed well. Then small pellets were prepared from each of the developed blends. After that each of the samples were placed separately in the plates and the corresponded random numbers were annexed with each of the plates. Then they were given for sensory evaluation by the panelists.

Value Added Snack Foods Development

Three kinds of value added snack foods were developed from the best basic mixture T₇, which was the best among the twelve developed basic mixtures in its nutritional and sensory attributes.

a) Flakes

Coconut milk was prepared by mixing the coconut milk powder in hot water. About 50ml of coconut milk was added with 100g of T₇ odial based breakfast cereal mix and was made as paste. The product was spread as thin layer in tray and baked in oven at 175°C for about two minutes. When the temperature reached to 90°C, the layer was made as small flakes using spoon. After reaching the target temperature that was taken out of the oven and was allowed to cold, then packed as air tight to protect its crispiness. The time and temperature for baking was determined by preliminary experiments.

b) Pellets

About 50ml of coconut milk was added with 100g of T₇ odial based breakfast cereal mix and mixed thoroughly with it. Then small pallets were prepared from that and baked in oven at about 150°C for about two minutes. The time and temperature for baking was determined by preliminary experiments. Then the pallets were allowed to cold and packed as airtight.

c) Ready to Serve Cereal Powder

About 50ml of coconut milk was added with 100g of T₇ odial-based breakfast cereal mix and mixed thoroughly with it. Then that was spread as a layer in tray and baked in oven at 80°C for about 90 seconds. After it had been allowed to cold, it was grounded to make as powder. The time and temperature for baking was determined by preliminary experiments. After that it was packed as airtight.

Nutritional and Sensory Evaluation of the Developed Products

The nutritional attributes such as moisture, ash, fat, protein, fiber and soluble carbohydrate of the developed products were analyzed using routine AOAC (1998) methods of analysis as done for the basic mixtures.

Sensory evaluation was carried out to select the best product. In this analysis the sensory characteristics such as taste, flavour, colour, texture, mouth feel and overall eating quality were evaluated flakes, pellets, ready to serve cereal powder and cereal mix wet pellets were placed in paper trays with corresponded random numbers. The wet pellets were prepared by mixing 25ml of coconut milk with 100g of T₇ odial-based cereal mixture and making small pellets from that dough.

Results and Discussion

Nutritional Analysis of Basic Mixtures

The nutritional compositions of the twelve developed basic mixtures were analysed during the experimental period. The mixtures are highly significantly differed among them in their moisture contents. According to Kordylas (1990) for a better shelf life, the moisture content of a mixture should be lesser than 5%. Therefore all of the mixtures, except T₁₁ can be considered as fit for the requirement in case of moisture content. The ash content exhibits highly significance difference among them. According to Sutharsan (2000), the ash content of the best supplementary food produced using maize, soybean was 3.05%. As the range of ash content obtained from the experimental results not much differs from the best-accepted maize, soy based product, these mixtures seems to be accepted according to ash content.

The result from the nutritional analysis shows highly significant difference among the mixtures in their protein content. The protein contents of Ranposha and Samaposha which are the breakfast cereal mixtures produced and successfully marketed in Sri Lanka are 20.2% and 19.6% respectively. It is obvious from the experimental results that the protein content of the all mixtures is higher in their protein content than the present marketed products. Using the pulses in considerably higher amount as the ingredient may be the reason for the relatively higher protein.

According to FAO/ WHO/ RDA, stated by Kordylas (1990) the fat content should not lesser than 2%. Thus the products, except T₁₀, T₁₁ and T₁₂ that are made of 20% odial, may suit for the requirement of the breakfast cereal mix in the case of fat content. The addition of relatively higher amount of green gram and black gram, which are comparably low in fat content than the cereals, may be the cause of the lower value of fat content of these products. Fiber content which express highly significant difference among the treatments. The fiber content of Ranposha is 1.4% and Samaposha is 1.5%. As the fiber content of the developed products seems to be very closer to the value of the marketed products, all of the products can be consider as acceptable in case of their fiber content. Soluble carbohydrate of the mixtures shows highly significance difference. The carbohydrate content of Ranposha is 62.7% and Samaposha is 64.4%. As the range of carbohydrate content obtained from the experimental results not much differ from the marketed products, the developed products can be considered as suitable according to their carbohydrate content.

Sensory Evaluation of Basic Mixtures

A pre-test done to screen the number of objects helps to increase the accuracy of the results (Stone and Sidel, 1993). Therefore, with the intention of increasing the precision of the results the sensory analysis was done in two steps. According to the results of the initial step, the best six mixtures were screened and subjected to the final sensory analysis.

Table 2: Final Sensory Analysis of the different Odial based Breakfast Cereal Mixtures

Treatments	Taste	Colour	Flavour	Texture	Mouth feel	Overall eating Quality
T ₁	7.04±1.48 ^{ab}	7.56±0.80 ^a	6.44±1.20 ^a	7.08±1.06 ^a	6.92±1.26 ^a	7.08±1.06 ^{bc}
T ₂	6.84±1.22 ^b	6.12±1.37 ^b	6.68±0.97 ^a	6.80±0.75 ^a	6.76±0.95 ^a	6.92±1.16 ^{bc}
T ₃	6.48±1.39 ^b	6.48±0.90 ^b	6.36±1.09 ^a	6.48±1.10 ^a	6.68±0.93 ^a	6.48±1.10 ^c
T ₄	7.76±1.58 ^a	7.74±0.75 ^a	6.80±1.36 ^a	7.32±1.29 ^a	6.84±1.35 ^a	7.60±1.36 ^{ab}
T ₇	7.84±1.59 ^a	7.76±0.95 ^a	6.80±1.30 ^a	6.88±0.91 ^a	7.12±1.21 ^a	8.00±1.23 ^a
T ₈	6.40±1.47 ^b	6.32±1.46 ^b	6.12±1.36 ^a	6.72±0.78 ^a	6.60±1.10 ^a	6.44±0.98 ^c

Table values are the means ± standard deviation of the replicates determinations.

Mean with the same letters in each columns are not significantly differed at 5% probability level.

Scale ranges from 9 - like extremely to 1 - dislike extremely.

Taste is one of the most important characteristic of any particular food product as it is considered as important by consumers than the nutritional value in many instances. In initial sensory analysis the score of basic mixtures do not exhibit significant difference among them, nonetheless in final sensory analysis that values highly significantly differ. The difference in taste may be exhibited because of the different amount of the ingredient. According to the taste, T₇ having the odial flour of 15% and made up of rice, maize combination is ranked as the best in both sensory analysis steps.

The most important sensory quality attribute of a food is colour, because no matter how nutritious, flavourful, or well textured a food, it is unlikely to be eaten unless it has the right colour. In case of colour T₇ ranked as first, whereas T₉ ranked as last among the twelve products. In both steps T₇, T₄, T₁₀ and T₁ which are made up of rice, maize cereal combination; and obtain high scores for their colour, do not reveal significant difference among them. The unfavorable darker colour of

the sorghum may be the cause for the lower value of the other products in colour. Flavour also can be considered as one of the important parameter of sensory attributes as it has a great impact on the consumption of food products. In initial as well as final sensory analysis, the developed cereal mixes are not significantly differed in their flavour.

According to the results there is no any significance difference in case of texture in both steps of sensory analysis. Addition of the black gram may be the reason for the sticky texture of the basic mixtures, especially in T₁, T₄, T₇ and T₁₀ which have been made up of rice maize combination. Mouth feel is considered as important because it is obvious that a food does not have satisfactory mouth feel could not be accepted by consumers even if it has all other organoleptic characteristics of desired level. The results showed that there is no any significant difference in their mouth feel in initial as well as final sensory analysis.

Overall acceptability is the most complex organoleptic property of food stuffs. The significance difference in overall eating quality is obvious in the results. According to the experimental results other than T₁₁, the products which are not significantly differed from the best were selected to subject to the final sensory analysis. Although the treatment T₁₁ can be considered as good in sensory value according to the results of overall eating quality, it was not selected for the further analysis because of its nutritional characteristics. The results from the final sensory analysis also indicate that the treatments are significantly differed among them in their overall eating quality. Although T₇ is the best among the six products it is not significantly differed from T₄, which is the next in overall eating quality

Nutritional Analysis of the Developed Products

The results obtained from the nutritional analyses of the developed products shown in Table: 3 do not show any significant different among them in any nutritional characteristics. Manufacturing of all products from the same mixture could be the reason for the absence of significant different.

Table 3: Nutritional Composition of Developed Products

Products	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Soluble carbohydrate (%)
Flakes	1.24±0.008	2.62±0.016	5.34±0.014	25.95±0.016	0.97±0.016	63.88±0.014
Pellets	13.42±0.016	1.89±0.008	6.59±0.008	25.55±0.016	1.27±0.016	51.28±0.016
RTS cereal powder	1.68±0.008	2.45±0.014	5.31±0.016	26.45±0.014	1.04±0.014	63.07±0.016
Cereal mix wet pellets	1.92 ±0.014	2.12±0.008	5.29±0.014	25.93±0.008	1.07±0.014	63.6±0.0147

Table values are the means ± standard deviation of the replicates determinations.

Sensory Analysis for the Developed Products

Statistical results acquired from analyzing the hedonic scale questionnaires that were completed by the panelists during sensory analysis are given in Table 4. Results of the sensory analysis of the developed different type of products revealed that, every product are significantly differed among them in sensory parameters.

Table 4: Results of sensory analysis

Products	Taste	Colour	Flavour	Texture	Mouth feel	Overall eating quality
Flakes	6.75±1.41 ^b	6.95±0.80 ^c	6.40±1.07 ^b	5.40±1.32 ^c	5.50±1.50 ^b	6.35±1.01 ^b
Pellets	6.95±1.28 ^b	7.35±0.91 ^{bc}	7.15±1.06 ^{ab}	6.70±1.31 ^b	5.90±1.92 ^b	7.05±1.24 ^b
RTS Cereal powder	7.85±1.62 ^a	8.10±0.44 ^a	7.50±1.20 ^a	8.05±0.92 ^a	7.65±1.35 ^a	7.95±1.28 ^a
Cereal mix wet pellets	8.05±0.97 ^a	7.75±0.59 ^{ab}	7.10±1.37 ^{ab}	7.90±0.62 ^a	8.00±0.77 ^a	8.30±0.84 ^a

Table values are the means ± standard deviation of the replicates determinations.

Mean with the same letters are not significantly differed at 5% probability level.

Scale ranges from 9, like extremely to dislike extremely.

In case of taste, the experimental results designate that, the four types of the products are significantly differed at 1% significant level; and the hedonic scale score ranges from 8.05 to 6.75, in which, the cereal mix wet pellets got the highest value where as the flakes got the lowest.

Slightly bitter taste, which may be resulted because of the relatively higher degree of temperature used in the production of flakes could be the reason for its less preference in taste. Even if the cereal mix wet pellets gained the highest score in taste, it is not significantly differed from the Ready-To-Serve (RTS) cereal powder which stands second to that. Similarly, there is no any significance difference among flakes and pellets in their taste. However flakes and pellets are significantly differed from RTS cereal powder and cereal mix wet pellets in case of taste.

The results from the statistical analysis indicate that, the four types of products are differed at 1% significant level, in their colour. RTS cereal powder got the highest score in colour, which is range from 8.10 to 6.95, while flakes obtain the lowest value for its colour. Slightly darker colour of the flakes which may be the consequence of the comparatively higher degree of temperature used in the production perhaps the reason for the less hedonic score for its colour.

The four different products exhibit significant difference at 5% level in their flavour. The highest score, 7.50 in flavour of the RTS cereal powder significantly differ at 5% level from the lowest value, 6.40 of flakes. The results from the sensory evaluation of texture are the sign of the expression of the significant difference among the four types of products in texture. With in the score of texture, the highest score, 8.05 acquired by RTS cereal powder, while the lowest value, 5.40 by flakes.

In case of texture, although there is no any significant different among RTS cereal powder and cereal mix wet pellets, both of they are highly significantly differ from the other two products; further more the flakes and pellets exhibits significant different among them also.

When considering the mouth feel of all of the products the score are ranges from 8.00 to 5.50; with in that range, the highest scoring is for cereal mix wet pellets, while the lowest scoring is for flakes. According to the experimental results, the four types of the products are significantly differed at 1% significant level in their mouth feel. Even though the cereal mix wet pellets acquired the highest score in mouth feel, it is not significantly differed from the RTS cereal powder that is ranked as second in its sense of mouth feel. Like wise the RTS cereal powder is

not significantly differed from flakes; on the other hand, the flakes and pellets are significantly differed from RTS cereal powder and cereal mix wet pellets in case of mouth feel. The lower scoring in mouth feel of flakes and pellets may have been resulted because of their hardness for bite. On the other hand the wetness of the cereal mix wet pellets may be the reason for its higher scoring in mouth feel.

As overall eating quality depends on all the sensory parameters, result of the overall eating quality reflects the results of the other sensory quality parameters such as taste, colour, flavour, texture and mouth feel. The score of overall eating quality, in which the cereal mix wet pellets got the highest score and the flakes got the lowest, is dispersed from 8.30 to 6.35. According to the experimental results, the four types of the products are significantly differed at 1% significant level in overall eating quality. As in the case of taste and mouth feel, the cereal mix wet pellets and RTS cereal powder which got the top scores are not significantly differed from one another; like wise flakes and pellets also do not show any significant difference among them. However cereal mix wet pellets and RTS cereal powder are significantly differed from flakes and pellets in their overall eating quality.

Conclusions

The findings of this study revealed that, all of the products other than those made up of 20% of odial, are well suited for the consumption in case of their nutritional attributes. Basic mixtures made up of rice, maize cereal combination are superior in their sensory attributes compared to other cereal combinations. Although there is no any significant difference between T_4 and T_7 , the mixture T_7 which is made up of 15% of odial with rice, maize combination is able to be concluded as the best because of its higher hedonic score in sensory evaluation.

Results from the nutritional and sensory analysis of the developed different types of products do not show any significant different among them where as the results from the sensory analysis of those revealed that, cereal mix wet pellets and Ready To Serve (RTS) cereal powder are the best among the four types of products. Although the cereal mix wet pellets obtained the highest scores in all of the sensory parameters, it is

not significantly differed from the RTS cereal mix powder. Therefore, RTS cereal mix powder can be concluded as good as cereal mix wet pellets in its sensory attributes.

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