
A REVIEW OF RICE BASED FOOD PRODUCT DIVERSIFICATION FOUND IN SRI LANKAN FOOD INDUSTRY

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ABSTRACT

Rice (*Oryza sativa* L.) is considered as one of the major element in food consumption patterns of Sri Lankans. The importance and contribution of rice towards healthy dietary patterns have been widely studied with the increasing health risks of wheat flour. Rice based food items are frequently consumed by Sri Lankans in traditional and domestic food practices since early days. Now the usage of rice flour in food industry is highly concerned with the usage of diversified market strategies. Rice products are now being introduced to the local market to benefit the modern life style of people. Rice is used as a major component in composite flour technology because of its proven quality and applicability in food industry. This review article gathers information about food items developed using rice as an important ingredient in Sri Lanka and provide an overview of rice based product diversification and development with the modern life style.

Keywords: Rice, Rice products, Market strategies, Food industry.

1. INTRODUCTION

In the modern world most of the people are much concerned about their health. Therefore, searching for healthy foods has become a good dietary practice. In recent years, food products based on cereal varieties are much accepted due to their nutritional and functional importance. Among the cereal crops grown in Sri Lanka, rice being the staple food in Asian countries is considered as one of the major components in Sri Lankan diets. Also it is considered as one of the most consumed cereals in the world (Ranawake, 2013; Choi et al., 2007). Paddy cultivation in Sri Lanka has sustained since about 3000 years and it is reported that traditional rice varieties possess various health benefits and bioactivities and had been used commonly in traditional, medicinal practices as well. Sri Lankans typically include cereals in their diets and rice plays a major role among them (Rajapakse et al., 2000; Gunaratne et al., 2013). There are many literature sources that outline the importance and health benefits of cereals and cereals based diets. Whole grain cereals also have been recommended by Dietary Guidelines throughout the world due to their high nutritional and functional values (Muntana & Srihanam, 2010; Laokuldilok et al., 2011; Sompong et al., 2011; Pengkumsri et al., 2015). Gliadin and Prolamins are proteins that basically present in wheat and rye respectively. Coeliac disease (CD) is a condition which occurs due to the inability of tolerating these proteins causing inflammations in the small intestine of humans. This condition may results in reducing the efficiency of absorbing important nutrients such as folic acid, iron, calcium and fat soluble vitamins. Improving dietary practices towards Gluten free diet is an important and effective remedy to reduce the risk of

CD. Developing food products especially bakery products free from gluten is challenging because gluten is an essential element in forming the unique appearance and crumb structure of these products. However rice flour has been identified as a good alternative to wheat flour and there are number of studies done to evaluate the quality of rice flour incorporated products and determine the suitability of replacing wheat flour. Further rice flour is preferred in food production due its hypoallergenic properties, unique trivial flavor, pale appearance and low sodium levels (Mancebo et al., 2015; Wu et al., 2019). Composite flour technology has thus become a critical approach in introducing rice based food products to the market.

2. REVIEW

2.1 Overview of rice-based food items

It is stated that main meals of Sri Lankans comprise of cooked rice and also hoppers, string hoppers, pittu, porridges, roti like other rice-based diets are more frequently consumed traditional meals by them. Most of the times these food items are prepared in domestic practice and consumed along with one accompaniment like sambol (Karunaratne, 2007). People are shifting away from consuming rice in traditional practice and moving to westernized diets with the increase in their income levels (Pingali, 2007). Now most of food products are available as readymade items in the local market as well. The advice of nutritionist is to improve the dietary diversification in order to get nutrients from different varieties of foods (Ministry of Health, 2016). Also, low dietary diversification has been detected as a key factor that contribute under nutrition (UNICEF, 2011). Production and introduction of fortified value-added rice-based products are in great concern. Modern market is more attentive towards introducing secondary rice-based meals too. This is typically very important in rice-based product diversification. With the modernized life style, dietary practices have been changed upon introducing different products to the market with different market strategies. People now always look forward to save their time and go for instant and easy dietary patterns.

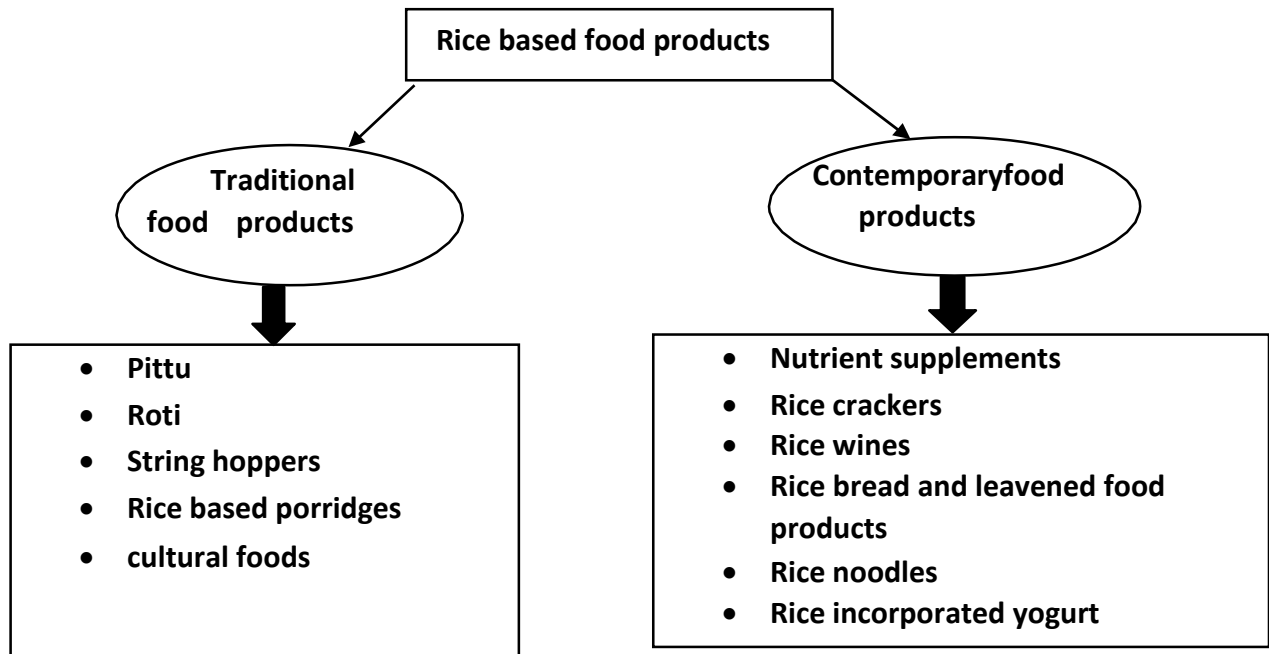


Figure 01: Different rice based food products consumed by Sri Lankans

2.2 Traditional food products

Pittu and Roti

Traditionally pittu is prepared by milled rice samples which are soaked in water for about 4 hours, drained off and grounded. Rice flour is then mixed with scraped coconut, salt and necessary amount of water and small pittu particles thus prepared are then subjected to steaming. Roti is prepared by mixing rice flour with necessary amount of water, cooking the ball in a pan for about 5 minutes (Annals of Sri Lankan Agricultural Department, 2016). However studies conducted recently have discussed about the importance of product fortification for these traditionally consumed items and have shown the importance of introducing diversified value added products to the market. These emerging studies comparatively discussed the importance and health benefits of rice based product fortification. A research has been conducted by Thathvasuthan et al to compare the effect of cereal type on Glycemic Index (GI) of pittu and roti (Thathvasuthan et al., 2017). Rice flour is the major ingredient used for preparation of these food items. Here the comparison of GI has been done with the replacement of rice flour by kurakkan flour (*Eleusine coracana* L.). Jenkins et al has pointed out that diabetes is one of the common Non Communicable Diseases (NCDs) in Sri Lanka and even there are many pre diabetic ones who will be readily prone to diabetes in near future. Also diabetes is associated with other NCDs like high blood pressure, heart attack etc. Therefore GI is an important and basic measure in implementing precautionary steps for these NCDs (Jenkins et al., 2002). In this research, kurakkan flour incorporated roti and pittu made from traditional methods has

been evaluated compared to those food items made using Bg 403 rice variety. The findings of this study have revealed that the average carbohydrate levels of rice and kurakkan flour were 73.7 and 69.0 respectively and the GI of pittu and roti made out of rice flour were 52 and 64 while that of kurakkan flour were 71 and 80. From the results obtained this study has made a conclusion that pittu is better than roti and rice flour is better than kurakkan flour based on the calculated GI values from the research. Further a feasibility study has been done by M.P.M.S.H. Perera by incorporating soy flour in preparation of pittu and roti (Perera, 2014). Rice flour (Bg-352), wheat flour (prima) and soy flour (Pb-1) have been used as ingredients in preparation of these food items. Atkinson et al., 2008 had indicated that international food tables include the GI of soy and has proven that soy incorporated foods have a lower GI. Perera

M.P.M.S.H. in this research has discussed the incorporation of soy flour to rice flour in breakfast foods. It has concluded that roti and pittu from soy flour incorporated rice flour had significant levels of higher proteins (19.05% to 24.3%), fat content (9.2% to 12.1%), ash content (1.9%) as well as lower carbohydrate content.

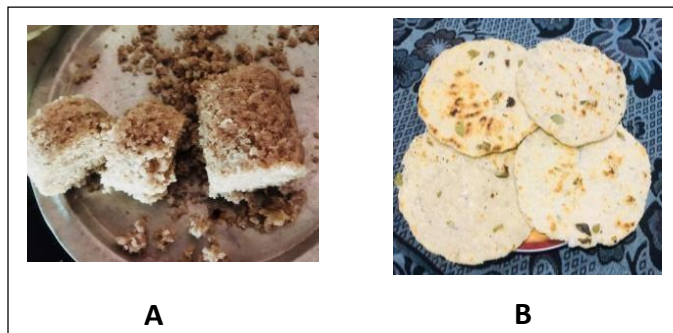


Figure 01: A; Pittu made from Red Rice flour, B; Roti made from white rice flour

String hoppers

String hoppers are more frequently consumed food item by Sri Lankans for breakfast or dinner. Literature has shown that (Samaranayake and Herath, 2019) fortified rice flour with iron and folic acid premix at the level of 40 ppm can be recommended in formulating rice products. This study has been basically done by evaluating quality and sensory attributes of roti, string hoppers and hoppers made from fortified rice flour. The survey reports from Medical Research Institute, Sri Lanka in 2001 shows that Iron deficiency is one of the most prevalent health problems in Sri Lanka. Also rice and rice based products are mostly consumed foods by Sri Lankans. Therefore using fortified rice flour with iron premixes in food industry is beneficial to overcome health problems related to the iron deficiency. Further, a study has been conducted by Pirasath et al to evaluate the effect of soluble fiber on Glycemic responses (Pirasath et al., 2012). Here the fiber content of pittu and string hoppers has been considered. It has been reported that string hoppers contained low SDF (0.43%), IDF (1.45%) and TDF (1.88%) than that of pittu. Also it has shown than these food stuffs contain more SDF than cooked brown rice, cooked parboiled rice and cooked

white rice as well. Therefore, they have given lower glycemic responses also.

Rice based porridges

Since past rice-based porridges are mostly consumed by people as a health remedy. Porridges can be made using different rice varieties. Especially Sri Lankans are more preferred to use traditional rice varieties due to their high nutritional value and less use of agro chemicals. Rice porridges can be used as a healthy food remedy and it is common among Sri Lankan community because it is easy to prepare, less expensive and easily digestible. Different literature show studies conducted to evaluate the health benefits of rice based porridges as well. A study has been conducted by Thushara et al to determine the phytochemical and antibacterial properties of rice based Sri Lankan traditional porridges (Thushara et al., 2021). Results of the study have been made based on four rice porridges using Madathawalu, kalu heenati, mixed rice porridge and a special traditional porridge. The study has concluded that these rice porridges contain phytochemicals and also they possess antimicrobial activity against some bacteria (*Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*) which cause most of the skin and tissue infections. In another study done by Senadheera et al, a marketable rice based herbal porridge with a low GI has been developed. Porridges of two types, one made from extruded rice, leaves, coconut, rice powder and the other sample with minimum extruded rice, other ingredients same as in the previous sample mixed with boiled and intact rice grains have been analyzed (Senadheera and Ekanayake, 2013). The first porridge sample has shown high GI, 92 ± 22 for normal subjects and 97 ± 20 for diabetic subjects while the second sample has shown low GI values, 58 ± 11 for normal subjects and 61 ± 11 for diabetic subjects. However these results have shown that intact rice grain porridge is good for health and has a more market value than the powdered one. Now a days there are many instant, ready to make, fortified porridge mixtures in the Sri Lankan market although published data on this area is limited.

Sri Lankan cultural food items

Milk rice is prepared by non- parboiled rice with the incorporation of coconut milk. Sometimes the preparations are done with the addition of mung beans where it enhances the nutritious quality and increase the essential amino acid profile as well. Sugar cane, grated coconut infused with concentrated sap of palm inflorescence is also being added sometimes (Mihiranie et al., 2020). In the research about “Study on developing micro nutrients enriched spread using fermented cooked rice”, it is mentioned that “Diyabath” which is the prepared using leftover cooked rice is good to reduce the gastric acidity (Jayawardena and Wansapala, 2015). A study has been conducted by kanchana and Thenabadu to develop a finger millet incorporated instant flour mixture for “kokis” (Kanchana and Thenabadu, 2021). Here, finger millet flour, rice flour, corn flour together with other ingredients have been used. 55% finger millet incorporated rice flour mixture has shown a higher acceptability.

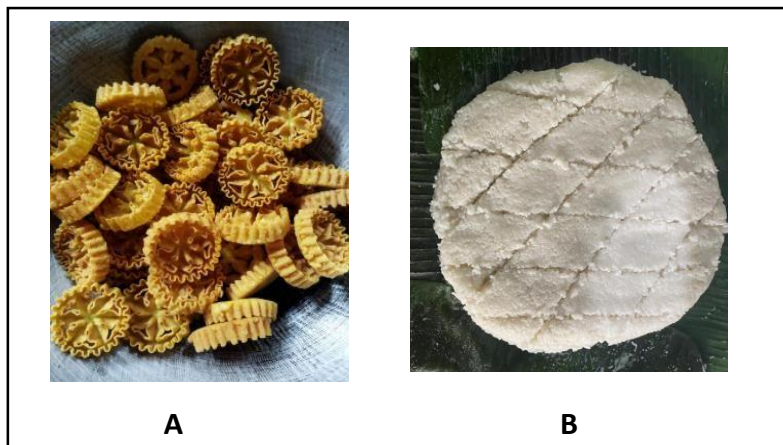


Figure 02: A; Kokis made using rice flour as a major ingredient, B; Traditional Milk rice preparation made using white rice

Table 01: Fortified traditional rice based food products studied in Sri Lanka

Traditional food product	Fortification of the product
Pittu and roti	Soy flour incorporated rice flour
	Iron fortified rice flour
String hoppers	Iron fortified rice flour
Rice based porridges	Fortified with <i>Scoparia dulcis</i> leaves
Kokis	Instant flour mixture fortified with finger millet and corn flour incorporated rice flour

2.3 Contemporary food products Cereal based nutrient supplements

Sri Lankans are obviously used to intake cereal based diets and supplementary foods prepared from local cereal varieties are in great concern. “Thriposha” is the most popular supplement among them. But only 40% of its ingredients are locally available and the rest is imported. Thriposha contain only maize and soya beans as major ingredients. “Samaposha” is also available in the market and it consists rice, soya, green gram, maize (Jayatissa et al., 2012). Jayatissa et al reported that these supplements are deficient in fats, dietary fiber and other micronutrients like phytochemicals.

Now, there are many cereal based, extruded “Samaposha” like fortified nutrient supplements in the market using different nutrient rich local cereal varieties. Many of these supplements contain rice as a major ingredient. The report on “Performance review of Rice Research and Development center at Batalagoda, Sri Lanka (2017)” has indicated that BG 352 variety as the ideal rice variety for “Samaposha” production. Now there are vast range

of products in the 'Samaposha' family with the incorporation of different ingredients and flavors in the Sri Lankan market. For example Samaposha red rice nutri mix, Samaposha choxy, Samaposha ready mix, Samaposha kurakkan nutri mix, Samaposha greens and grains, Samaposha milky are some of them. As there are no enough published data on basis of these products in Sri Lanka, it is of great importance.

Rice crackers

Crackers have been identified as snacks with low sugar and salt levels and moderate levels of fat (Han et al., 2010). Accordingly they can be utilized as replacements for sweet snacks. Also crackers can be fortified and diversified to different formulae by incorporating nutritionally rich ingredients (Sudha et al., 2007). A research has been conducted by Gunaratne et al in order to select suitable rice varieties for cracker production (Gunaratne and Gunaratne, 2017). This research has been conducted with the use of locally bred AT 306, AT 405 and samba rice varieties. Stickiness is considered as one of the major parameters in cracker production which depends on the amylose content of the food variety. In this research, suitability of these rice varieties in cracker production has been determined with compared to their stickiness. However results have shown that AT 306 and AT 405 were the low amylose rice varieties with recorded values of 19.6% and 12.2% respectively while samba variety had a 25.87% amylose content. It has been shown that AT 306 and AT 405 varieties are suitable for cracker production while samba was not. Furthermore the shelf life of rice crackers based on two flavors, savory and sweet has been determined (Gunaratne et al., 2015). This has been done basically on extending the shelf life of rice crackers. The results have indicated that odor was a critical factor in shelf life determination and the packed savory and sweet rice cracker samples with the incorporation of desiccant and oxygen absorbents had shelf lives of 11 and 9.2 months respectively. Also another study by Gunaratne et al shows that sensory as well as chemical factors like moisture content, pH, FFA affects the shelf life of rice crackers (Gunaratne et al., 2014).

Rice noodles

A research has been conducted to develop an instant rice noodles by Chandrajith et al and the quality characteristics evaluation also have been done (Chandrajith et al., 2014). Noodles are identified as a mostly consumed food in the world (Jayasena et al., 2008). Juliano and Sakurai have reported that long grain rice which contain high amylose content is usually used for traditional rice noodles preparation (Juliano and Sakurai, 1985). Also other studies have shown that there is a considerably high correlation between the acceptability of rice noodles and the amylose content of rice (Yoenyongbuddhagal and Noomhorm, 2002). Jayasena et al basically have focused to introduce an instant cup noodle to the market. "Take away concept" can be stated as a good market strategy for the modern life style. BG 358 white rice variety has been used for the study. The study has concluded that the product is 4.83/5.00 acceptable from the sensory evaluation. Another study has been done by M.J.M. Fari to evaluate the quality characteristics of noodles made from different rice varieties in Sri Lanka (Fari et al., 2011). The study has been made possible with Bg 300, Bg 352, Bg 403, B8 94-1, Ld 356, BW 272-6b, At 405 and At 306 rice varieties. Here the lowest acceptability score has been recorded for At 405 variety and the highest score for the Bg 300 variety. Further, the correlation between the amylose content

of rice varieties and other qualities like swelling ratio, cooking loss, tensile strength, extensibility and elastic recovery also have been evaluated in this study.



Figure 03: Extruded Noodles and Pasta products with some other commonly used accompaniments

Rice incorporated bread and leavened food products

In the complicated society people have made their food patterns as to make the life style easier. With that consumption of bread has increased continuously (Seibel, 2006). As reported by Wickramasinghe and Noda, rice flour obtained from traditional rice varieties contain high amounts of nutrients (Wickramasinghe and Noda, 2008). However gluten protein which is mainly contain in wheat flour is an essential element is maintaining the unique structural properties in bread production (Owens, 2001). Absence of gluten protein in rice flour is a challenging factor in rice bread production. A study has been done to evaluate the quality characteristics of rice flour incorporated bread (Peris et al., 2017). Here four traditional rice varieties, Madathawalu, Kaluheentai, Panchaperumal, Rathdal have been used. The study has revealed that bread prepared by incorporating 40% rice flour and 60% wheat flour as the best treatment formulae of the composite flour bread. Also this formulae has possessed similar sensory attributes to that of bread prepared from 100% commercial wheat flour. The effect of different rice varieties in bread production has been discussed in several literature sources. In a study by M.J.M fari, incorporation of rice varieties namely Bg 300, Bg 352, Bg 403, Bg 94-1, Ld 356, Bw 272-6b, At 405 and At 306 in bread making have been evaluated. Here the results have shown that Bg 94-1 rice variety had the highest overall acceptability in the sensory evaluation. Incorporation of 30% rice flour to wheat flour had a significant contribution to the quality characteristics of the final product. Also bread with high specific loaf volume have been produced with rice varieties, Bg 352, Bg 300, Bg 94-1, and At 405. Sivakanthan et al also have determined the acceptability and nutritional quality of malted rice- wheat bread (Sivakanthan et al., 2010). The results have revealed that 35% incorporation level of rice flour to wheat flour had the best score from sensory and quality evaluations. The dietary fiber contents of the samples also have been determined in this study and it shows that rice- wheat bread contain more soluble dietary fiber (0.62%) and insoluble dietary fiber (3.95%) than that of wheat bread available commercially. Rathnayake et al have done a study to develop a leavened food product with a proper structured crumb using a rice based composite flour mixture

(Rathnayake et al., 2021a). As concluded by recent literature sources, the global food market has a high demand towards using alternative flours to wheat flour in production of leavened baked foods using composite flour technology (Menon et al., 2015). Results of this study have concluded that the crumb developed from the formulation, Rice: Wheat: Corn: Green gram, 50:40:5:5 has yielded a better leavened food product with structural and textural properties. Another study by Rathnayake et al has evaluated the effect of process variables on functional properties of rice flour and the structural properties of leavened food products (Rathnayake et al., 2021b). Here, a method of heat moisture treatment followed by wet grinding has given out leavened dough with an improved gas retention capacity. Also a well-structured porous leavened product has been developed by applying an external pressure of 1.0 kg/cm². This treatment has been identified as a modification method of rice flour in developing well-structured leavened foods.

Rice wine

Rice wine has become a popular alcoholic beverage in the community because it has a unique taste compared to that of other alcoholic beverages. Here a bacterial culture is used to saccharifies rice starch from steamed rice grains (kodama et al., 2002). Rice being the major ingredient effect the quality of the final product. Polishing of rice grains are done before the brewing process begins in order to remove the unnecessary constituents (Furukawa et al., 2003). Plenty of studies on rice wine has not been done in Sri Lanka. A study has been conducted by Wellala et al to compare the liquor quality of rice wine as affected by different yeast strains isolated from different substrates (Wellala et al., 2006). Here Bg 358 rice variety has been used. The ethanol content of rice wine produced using different yeast strains isolated from coconut and palmyrah has been recorded as in the range of 11.1%- 15.2%. Furthermore the most prominent headspace volatiles of rice wine has been studied. Another study has been conducted by Archchige et al to evaluate the quality of rice wine affected as per the polishing ratio (Archchige et al., 2006). In this study, Bg 358 rice variety polished at different ratios up to 90%, 80%, 70%, 60% levels has been evaluated qualitatively. The results have shown that the rice variety polished at the levels of 70 and 60 had the higher fermentation rates, higher sugar and alcohol contents and more headspace volatile constituents compared to that of 90% and 80% levels of polished rice. Also here, it has been found that the rice polished up to the levels of 60-70% have found to be better for wine production than that of 80- 90% levels. Also it is reported that rice fermented beverages have a demanding and profitable market in the world. Typically this would be a good opportunity for Sri Lankan market to capitalize and export these fermented beverages (Ismail & Mujahid Hilal, 2016).

Rice incorporated Yogurt

A study has been conducted to develop a yogurt based weaning food with the incorporation of brown rice, mung bean and soybean in order to enhance the nutritional value of the product and provide a recommended value added product for toddlers. As reported by a recent study (Nakagahra et al., 1975) brown and red rice contain much more protein, vitamins and minerals over common rice varieties. Another study done recently showed that brown rice is good to reduce the risk of diabetes over white rice (Sun et al., 2010). This

product has been introduced as an alternative nutritious weaning food for low income families in Sri Lanka. The proximate analysis has proven that this product is nutritionally better than that of other weaning products in the market. (M.A.D.D. Munasinghe). Also the sensory evaluation of the product has been evaluated to develop a better formulae of the product.

Table 01: Rice based contemporary food products and market strategies studied in Sri Lanka

Food product	Market strategies
Cereal based nutrient supplements	Extrusion technology Product fortification Composite flour technology Flavor differentiation
Rice crackers	Product fortification (fortified with herbs) Flavor differentiation(sweet, savory)
Rice noodles	Instant cup noodles (Take away concept)
Bread and Leavened food products	Composite flour technology
Rice incorporated yoghurt	Product fortification (fortified with brown rice, mung bean, soy flour)

3. CONCLUSION

The article basically focus to overview different rice incorporated foods in Sri Lanka. Still there are limited studies published on this area which depict rice based food production in Sri Lanka. For instance rice flour cakes, rice vinegar, rice milk, rice syrups, puffed rice snacks are much concerned in other Asian countries with the development of different market strategies now. Although Sri Lanka is a country rich in traditional rice varieties with many health benefits and bioactivities, some of these rice varieties in food industry have not been significantly utilized other than consuming as cooked rice. However, with the increasing risk of CD, much concern has given towards the utilization of rice and other cereals in food production. Therefore, further studies on utilizing rice in food industry to make people's lives easier have become important.

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