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# CAPACITY BUILDING FOR RESEARCH AND INNOVATION IN DISASTER RESILIENCE

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Cinnamon Lakeside | University of Moratuwa | University of Colombo
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CAPACITY BUILDING IN RESEARCH AND INNOVATION IN DISASTER RISK REDUCTION

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# Emergency food from rice related composite flour with functional ingredients for disaster resilience

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## *Abstract*

This study is based on developing safe and secure, nutritious rice related emergency food with improved structural properties for disaster resilience. Therein, baked crumb slices can be prepared by fermenting and gelatinizing dough under 1 kgcm$^{-3}$ initial air pressure, followed by slicing and baking to obtain a well porous, crunchy and low moisture product with a stable and less breakable structure using rice related composite flour from locally available food sources.

***Key words*:**

*Bakery Product; Disaster Situations; Emergency Food; Food Safety and Security; Rice Flour*

## 1. Introduction

A Disaster is defined by WHO/EHA (2002) as: "an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the affected community" (p. 3). Disasters can be induced both naturally and due to human activities. The most frequent natural disasters include floods, landslides, droughts and cyclones (Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship, 2009). Industrial accidents, terrorism and cyber-attacks can be identified as the most common man made and technological disasters.

Due to natural disasters, food in affected areas can easily get contaminated leading to a mass outbreak of food borne illnesses including diarrhea, cholera, typhoid fever and hepatitis A (World Health Organization). These food safety risks occur mainly due to poor sanitary practices and unhygienic conditions during food processing, storage, distribution and consumption as well as lack of safe water in the affected areas. Hence, supplying secure food that fulfills the nutritional requirements of the affected communities is a significant challenge (Cooper, 2018).

The concept of resilience has been introduced to overcome such challenges (Tendall et al, 2015). Disaster resilience has been defined by the Department for International Development, United Kingdom (2011) as: "the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses such as earthquakes, drought or violent conflict without compromising long-term prospects" (p. 6). In the case of food, certain international organizations have become interested and worked towards introducing the concept of building resilient food systems for disaster situations. A food system that provides a reliable source of safe, nutritious and accessible food even in harsh conditions is called a resilient food system (Biehl, Buzogany, Baja and Neff, 2018), which is mainly focused on building resilient food production systems (mainly focusing on agriculturally resilient), resilient food supply systems (proper supply of secure, valued added food items) and socio-economic resilient (develop food policies and supply of foods from local sources) (Pacific Community, 2015).

Having a good storage of emergency food supply is an important part of disaster resilience. When a sudden disaster occurs, people get isolated due to loss of electricity and communication. An emergency food supply will then help in fulfilling dilatory requirements until recovery from the disaster or until outside help is offered. Simply, emergency food can be identified as food that are high in nutritional and calorie value (Texas A&M AgriLife Extension, 2004), that require no refrigeration, water or special preparation techniques (Texas A&M AgriLife Extension, 2004; The Federal Emergency Management Agency, 2004). These products should not be salty (because that can make the persons thirstier) (University of California, 2009) and should be properly packed in affordable sizes (small serving sizes) (University Of California, 2009; Texas A&M AgriLife Extension, 2004). Further, when planning an emergency food supply system, dilatory requirements, preferences and allergic responses of individuals should also be considered.

In the case of Sri Lanka, having an emergency food supply for disaster resilience is not very common. Hence, the government and institutions can organize different workshops to make the community aware of the importance of having a good storage of disaster resilience emergency foods and educate them to plan such systems.

Mostly at household level, it is recommended to have an emergency food storage for several days. Ready-to-eat canned foods (Ex: meats, fruits, vegetables) are the most recommended emergency food for disaster resilience. In addition, Smoked or dried meats (Ex: beef jerky), Canned, powdered or crystallized juices, Soups, Powdered or canned milk, Staples (Ex: sugar, salt, pepper), High energy foods (Ex: peanut butter, jelly, crackers, nuts, trail mix), Stress foods (Ex: sugar cookies, hard candy, sweetened cereals), Vitamins and other dilatory supplements, Pet food and Water (1 gallon of water per person per day) have also been claimed as emergency foods (University Of California, 2009; Texas A&M AgriLife Extension, 2004; The Federal Emergency Management Agency, 2004).

Product innovations and value additions can be conducted by introducing new products, processing methods or improving the properties of existing products for the purpose of making them ideal for different conditions and/or for a certain group of consumers. As an example, according to the concepts of building resilient food supply system and building socio-economic resilient, ready to eat low moisture nutritious food products can be developed from locally available underutilized food sources using suitable processing conditions and packed in proper packaging material in affordable portions to store for a period of time without being subjected to spoilage or any quality deterioration to make them suitable for recommending as emergency foods for disaster resilience.

## 2. The objective of the study

This study is mainly focused on developing baked crumb slices with the application of pressurized conditions to obtain a low moisture product with a well-developed porous crumb structure from rice related composite flour that is easy to handle during storage, transportation and distribution. Further, this study is focused on enhancing the nutritional and functional properties of the developed product for the purpose of introducing a safe and nutritious emergency food for disaster resilience.

## 3. Materials and Methods

### *3.1. Sample preparation*

Dough was prepared by substituting wheat flour with 50% Rice flour into 100% flour basis according to the straight dough method and approximately 20±0.05g dough portions were loaded into cylindrical containers. Thereafter, the dough samples were subject to fermentation followed by gelatinization at 1kg/cm$^2$ initial pressure conditions in a closed chamber. The gelatinized crumb samples were cut into slices of 3±0.5mm and baked at 170±1$^{o}$C for 40 minutes to obtain a crunchy product with moisture content between 1.2-1.6%.

### *3.2. Sensory evaluation*

Sensory evaluation was conducted to evaluate the organoleptic properties of the baked crumb slices that have been developed under pressure (227), with respect to a control (127) (crumb sample prepared without pressure application) using a five-point hedonic scale with 30 panelists by considering five sensory attributes namely crumb appearance, aroma, texture, taste and overall acceptability.

### *3.3. Crumb Moisture content and storage stability*

Baked crumb slices were packed in double lamination (PET(20 µm)/LLDPE (50 µm) packaging material and stored at room temperature conditions (30±1$^{o}$C, 68±5% RH) for six months and the moisture content of the baked crumb slices were determined using the AOAC official method 925.10 (Official Methods of Analysis of AOAC, 16$^{th}$ ed, 1999) at three months intervals.

### *3.4. Statistical analysis*

The collected non-parametric data were analyzed by the Mann Whitney U test using Minitab 17 Statistical Software. All analyses were conducted at 95% confidence level. Graphical representations were done using Microsoft Excel 2013.

## 4. Results and Discussion

Figure 1 represents pictures of the baked crumb samples prepared under pressurized (study sample) and unpressurized conditions (control sample) whereas, figure 2 represents the web diagram for sensorial properties of the two samples according to the results obtained from statistical data analysis.

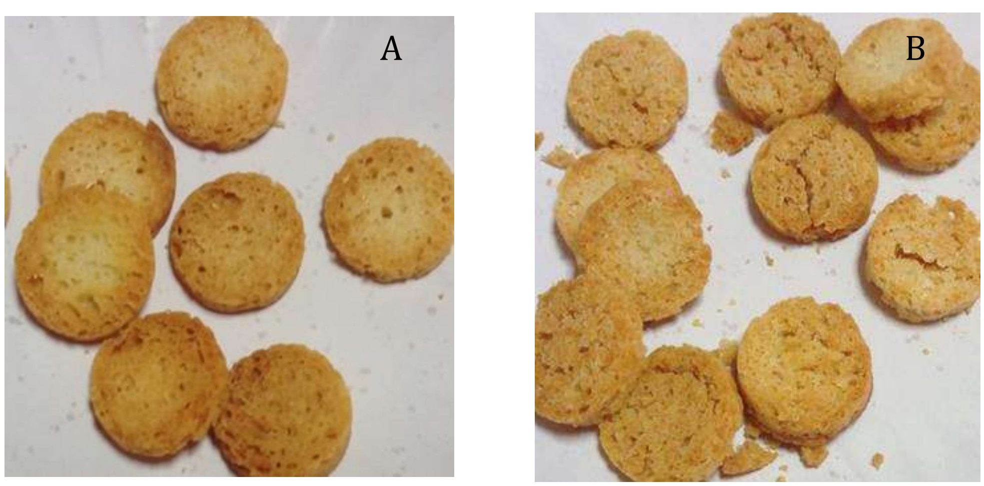


***Figure 5.*** *Baked crumb slices, (A) Study sampple, (B) Control sample*

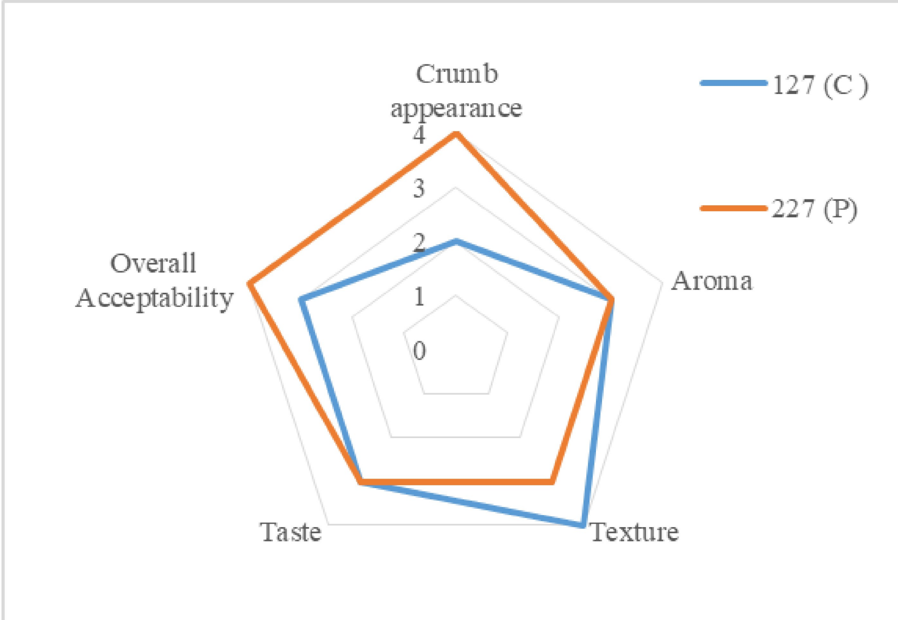


***Figure 6.*** *Sensory evaluation of the two samples, 227 (P) Study sample, 127 (C) Control sample*

According to figure 2, the study sample (227) has better acceptance in terms of crumb appearance due to its uniform and well developed porous crumb structure. Since the study sample has a harder texture, it gained less preference for the texture parameter compared to the controlled group (127). Product aroma and taste represent the presence of different volatile and nonvolatile components. Aroma and taste of the two samples do not show any significant difference ($P \geq 0.05$). When considering the overall acceptability, the study sample has significantly higher ($P \leq 0.05$) preference than the controlled group. Hence it can be concluded that the baked rice crumbs developed under this study shows better consumer acceptance and perception (especially regarding the porous crumb structure) than the controlled sample prepared without the application of pressure (under normal atmospheric conditions).

Certain food additives such as food hydrocolloids/ gums (Ex: Hydroxypropylmethylcellulose, Xanthan gum), emulsifiers, enzymes (Ex: alpha-amylases from different origins such as cereal, fungal and bacterial) have been commonly applied by researchres to improve porous crumb stucture, to enhance crumb texture and to retard crumb staling (Rathnayake, Navaratne and Navaratne, 2018) specially in developing gluten free bakery products. Hence, those food additives can also be tested with the pressurized product to further enhance the porous crumb structure as well as to reduce crumb hadness.

Table 1 shows the moisture content of the baked crumb slices (developed under pressurized conditions) at three month intervals. Development of well porous crumb structure can be beneficial as it can effectively remove moisture from the product to give a low moisture product. The initial moisture content of the product is 1.43 ± 0.22 %. Hence it can be considered as a low moisture product. Therefore, if packed in proper packaging material with higher barrier properties and stored in optimum conditions, low moisture products have a very low susceptibility of microbial spoilage (Morais et al., 2018) as well as due to the stable structure in pressurized product, it is more convenient for packaging, storage and handling.

**Table 5.** Moisture content of the product at three months intervals

| Time | Moisture Content (%) |
|---|---|
| Initial | 1.43 ± 0.22 |
| After three months | 3.78 ± 0.46 |
| After Six months | 6.40 ± 0.52 |

Certain cereal flour types such as Corn, Finger millet, Gram, Green gram as well as flour from certain yams and root crops such as Cassava, Purple yam, Sweet potato etc. can be incorporated into the composite flour mix by further reducing the wheat flour content. In addition, the product can be further improved with locally available under-utilized highly nutritious/functional food sources such as, dehydrated *Moringa olifera* leaves, dehydrated *Murraya koenigii* leaves, *Artocarpus heterophyllus* seed flour, soaked/germinated *Trigonella foenum-graecum* etc. A study conducted by Rathnayake and Navaratne (2017) proved that blanched dehydrated *Moringa olifera* leaves are a good source of protein and beta carotenes and incorporation of 5% blanched dehydrated *Moringa* leaves can improve the nutritional property of biscuits. Drisya, Swetha, Velu, Indrani and Singh (2015) have incorporated 0-15% dehydrated *Murraya koenigii* leaves powder into cookies and obtained that the content of protein, dietary fiber, iron, calcium and β-carotene as well as the radical scavenging activity has been increased with increasing amount of dehydrated *Murraya koenigii* leaf powder. Further, they have proved that cookies incorporated with dehydrated *Murraya koenigii* leaves up to 10% received better consumer acceptance with respect to sensory evaluation. Wani and Kumar (2018) have described in a review article that the application of germinated *Trigonella foenum-graecum* up to about 10% can improve nutritional and functional properties of biscuits. Further they have mentioned that *Trigonella foenum-graecum* can perform lipid lowering activity and the intake of *Trigonella foenum-graecum* incorporated products can be beneficial for people suffering from iron deficiency anemia.

Finally, the nutritional, antioxidant and organoleptic properties as well as the microbial stability during storage can be determined for the finalized product. Since those low moisture baked crumb slices are ready to eat, are not salty, do not require any refrigerated storage conditions and can be consumed as a safe and nutritious product by consumers in any age, they can be ideal for recommendation as emergency foods for disaster resilience not only for Sri Lankans but also for the global consumers as well.

## 5. Conclusion

Fermentation and gelatinization under pressurized conditions have improved rice flour incorporation percentage to obtain a low moisture product with better crumb properties. Baked crumb slices can be further developed to a safe, secure, healthy and nutritious product that can be consumed conveniently as an emergency food in disaster situations.

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## References

World Health Organization (WHO)/ Emergency and Humanitarian Action (EHA) Panafrican Emergency Training Centre. (20002). Disasters & Emergencies Definitions. Retrieved from: Available from: http://apps.who.int/disasters/repo/7656.pdf. (Accessed 5 January 2019)

Disaster Management Centre, United Nations Development Programme in Sri Lanka, United Nations Development Programme Regional Centre, Bangkok. (2009). Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship (Draft Report for Review). Retrieved from: https://www.preventionweb.net/english/hyogo/gar/background-papers/documents/Chap3/Asia-overview/Sri-Lanka-DRAFT-march-09.pdf. (Accessed 7 February 2019)

World Health Organization (WHO). Ensuring Food Safety in the Aftermath of Natural Disasters. Retrieved from: http://www.searo.who.int/entity/emergencies/documents/guidelines_for_health_emergency_fsadvice_tsunami.pdf?ua=1. (Accessed 5 January 2019).

Cooper, C.C. (2018). Emergency Food during Natural Disasters. Today's Dietitian, 20(1), 34. Retrieved from: https://www.todaysdietitian.com/newarchives/0118p34.shtml. (Accessed 5 January 2019

Tendall, D.M. Joerin, J. Kopainsky, B. Edwards, P. Shreck, A. Le, Q.B. Kruetli, P. Grant, M. and Six. J. (2015). Food system resilience: Defining the concept. Global Food Security. 6(2015), 17-23. http://dx.doi.org/10.1016/j.gfs.2015.08.001

Department for International Development. (2011). Defining Disaster Resilience: A DFID Approach Paper. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/186874/defining-disaster-resilience-approach-paper.pdf. (Accessed 5 January 2019).

Biehl, E. Buzogany, S. Baja K. and Neff. R. (2018). Planning for a resilient urban food system: A case study from Baltimore City, Maryland. Journal of Agriculture, Food Systems, and Community Development. 8(2), 39-53, https://doi.org/10.5304/jafscd.2018.08B.008

UN Office for Disaster Risk Reduction (Pacific Community). (2015). Resilience to climate change and disasters in the Pacific: We can build resilient food systems. Retrieved from: http://www.pacificdisaster.net:8080/Plone/resilience-infographic/. (Accessed 5 January 2019).

Texas A&M AgriLife Extension. (2004). Emergency Food and Water Supplies. Retrieved from: https://texashelp.tamu.edu/browse/disaster-preparedness-information/emergency-food-and-water-supplies/. (Accessed 5 January 2019)

The Federal Emergency Management Agency. (2004). Food and Water in an Emergency. Retrieved from: https://www.fema.gov/pdf/library/f&web.pdf. (Accessed 5 January 2019)

University Of California. (2009). Food Safety Information for Earthquakes. Retrieved from: http://ucfoodsafety.ucdavis.edu/Emergencies/Food_Safety_Information_for_Earthquakes/. (Accessed 5 January 2019)

Official Methods of Analysis of AOAC (Association of Official Analytical Chemists) International. 1999. 16th edition, 5th revision

Rathnayake, H.A. Navaratne, S.B. and Navaratne, C.M. (2018). Porous Crumb Structure of Leavened Baked Products. International Journal of Food Science. Volume 2018, Article ID 8187318, 15pages. https://doi.org/10.1155/2018/8187318

Morais, M.P.D Caliari, M. Nabeshima, E.H. Batista, J.E.R. Campos, M.R.H. Soares Júnior, M.S. (2018). Storage stability of sweet biscuit elaborated with recovered potato starch from effluent of fries industry. Food Science and Technology. 38(2), 216-222. https://doi.org/10.1590/fst.32916

Rathnayake A.R.M.H.A. and Navarathna. S.B. (2017). Utilization of Moringa olifera leaves as a functional food ingredient in bakery industry. International Journal of Science and Research. 6(2), pp. 339-344. doi:10.21275/ART2017641

Drisya, C. R. Swetha, B. G. Velu, V. Indrani, D. and Singh, R. P. (2015). Effect of dried Murraya koenigii leaves on nutritional, textural and organoleptic characeteristics of cookies. Journal of Food Science and Technology. 52(1), 500-506. DOI 10.1007/s13197-013-1002-2

Wani S.A. and Kumar. P. (2018). Fenugreek: A review on its nutraceutical properties and utilization in various food products. Journal of the Saudi Society of Agricultural Sciences. 17(2), 97-106. 2018. https://doi.org/10.1016/j.jssas.2016.01.007