Chapter 1
Introduction

1.1 General Introduction

Rice (*Oryza sativa* L.) is the most important and widely consumed staple food for Asian countries. In Asia, the total rice produce is about 671 million tons [7] and almost half of the world's population consumes rice as their staple food. Rice has two species: *Oryza sativa* L. and *Oryza glaberrima* Steud. *Oryza sativa* species is originated from South-East Asia and *O. glaberrima* is native to West Africa and is grown solely in this part.[8] Although, white rice is consumed worldwide, some Asian countries also consume pigmented cultivars like black rice, purple black, red rice, and reddish brown rice etc. Pigmented rice has been consumed in glutinous rice and husked rice (4.9%) also contains colored rice cultivars. In India, the total cultivated area has been recorded as 43.77 M ha (29.4% of the global rice area) with a production of 90 million tonnes and productivity of 2.203 t ha^{-1}.[17] 'Njavara' (*O. sativa* L.) is a unique, indigenous, medicinal rice variety that matures in about 70 days' time and cultivated in Kerala, India. Njavara is of two types *viz.*,'black glumed' and 'yellow glumed' and named on the basis of the color of the outer covering of paddy. Black glumed njavara has reddish bran.[15] Although, India is an immense source of rice, there is still a great amount of rice that remains underutilized and the most underutilized rice cultivars are prevalent in some regions, e.g., south, east and the hilly tracts of the North-East. The North-East region in India is considered to be one of the richest genetic resources in the world and a potential rice-growing region with extremely diverse rice-growing conditions compared with other parts of the country. The most important indigenous rice cultivars available are pigmented rice. Some of the underutilized rice cultivars of Arunachal Pradesh, India are pigmented and nonpigmented rice and can be a source of various bioactive compounds. The pigmented rice mainly comprises various mixtures of color *viz.*, black,[3] red and dark purple rice,[4] brown,[28] dark brown.[14] A study conducted in Thai pigmented rice varieties showed anti-glycation capacity and proanthocyanidins in red rice bran also exhibited moderate chelating activity.[5] Surarit et al.[23] reported that the pigmented rice extracts are very strong intracellular candidates inside the cell-based systems. Various researchers mentioned that the lightness (L^*), redness (a^*) and yellowness (b^*) values of pigmented rice are strong indicators of its bioactive components. Murdifin et al.[18] also reported that out of thirteen Indonesian pigmented rice, the darkest rice shown the lowest L^* value and highest a^* value.

Purple fruit is well known for its nutritional benefits and medicinal properties and its rind has the anti-hypertensive effect and vasodilatory effect on human body. [19, 20]

To increase the shelf life and protect the phytochemical loss of passion fruit, it needs an effective way of drying. The application of foam mat drying techniques can be an effective way to increase the shelf-life and decreases the phytochemical loss.[12]

In foam mat drying, for the porous structure of the foamed materials, mass transfer is faster, hence shorter the drying time apparently results in higher quality of dried food product.[1] Foam mat drying converts thin pulp into stable foam by whipping after the addition of edible foaming agent. Eventually, the whipping process increases surface area, and speed up the drying rates which yield dried foam mat powder of acceptable quality in reduced time span.[13]

Extrusion cooking of foods has been practised over 50 years. A twin-screw extruder mainly consists of two parallel screw shafts with the same length. The shaft which rotates in the same directions is called co-rotating and one which rotates in opposite directions called counter-rotating. Furthermore, it is subdivided into full, partial or non-intermeshing units on the basis of the relative position of the screws.[21] It is quite popular for agro-processing industries, such as pet food, cereals and snacks etc. [25]

Rheology plays a vital role in food manufacture and marketing nowadays *viz.*, design of handling systems, quality control and evaluation of sensory stimuli of viscosity.[2] It also concerned with how all food materials respond to applied forces and deformations. A flow model may be considered to be a mathematical equation that can describe rheological data, such as shear rate versus shear stress, in a basic shear diagram. It provides a convenient and concise manner of describing the data.

Fuzzy logic is a very important tool which aids in important decision-making for comparing a developed product with similar products available in the market. This evaluation will be used to determine the reasons for low and high ranking of products which was evaluated by the no. of judges. Various food products are available in the market.[9] Various researcher has reported the usefulness of fuzzy logic e.g. such as mango drinks, coffee, black rice wine etc.[16,11]

Moisture sorption isotherm (MSI) study is considered as a key tools for determining suitable packaging, storage conditions and optimized product stability.[5] According to Viswanathan et al.[24] MSI is the relationship between total moisture content and the water activity of the food at a constant temperature. Various mathematical models are also available to describe water sorption isotherms of food materials.

Diabetologists stated that there is a relationship between the intestine and insulin secretion. Dipeptidyl peptidase-4 (DPP-4) inhibitors act as a blood glucose lowering

treatments of patients with type 2 diabetes mellitus. DPP-4 inhibitors stimulate GLP-1, and GIP, which enhance glucose-dependent insulin secretion and inhibit glucagon secretion.[9, 22]

1.2 Hypothesis

- Foam mat dried powder from purple passion fruit juice can be successfully achieved.
- Cereal (red rice) based extruded product incorporated with passion fruit powder by twin extruder showed a new combination of ready to eat product
- Assessment of antidiabetic property from red rice and red rice based extruded products

1.3 Technical objectives

a) To study the physicochemical analysis of pigmented and nonpigmented rice and

phytochemical analysis of purple passion fruit

b) To study the foam mat drying of purple passion fruit and characterization of the powder

c) To study the effect of extrusion cooking on the physicochemical and phytochemical properties of passion fruit powder incorporated red rice extrudates, rheology of doughs and sensory evaluation of product

d) To study the moisture sorption isotherm (MSI) and antioxidant stability of optimized product during storage

e) To study the assessment of the antidiabetic potential of red rice and rice-based products

References

[1] Brygidyr, A, M., Rzepecka, M, A. and McConnell, M, B. Characterization and drying of tomato paste foam by hot air and microwave energy. *Canadian Institute of Food Science and Technology Journal*, 10:313-319, 1977.

[2] Barnes, H, A. in "Industrial Food Processing: Experiments and Numerical Simulation", University of Plymouth, Institute of Non-Newtonian Fluid Mechanics and British Society of Rheology, 2001.

[3] Chinprahast, N., Tungsomboon, T. and Nagao, P. Antioxidant activities of Thai pigmented rice cultivars and application in sunflower oil. *International Journal of Food Science and Technology*, 51:46-53,2016.

[4] Chen, M, H., McClung, A, M. and Bergman, C, J. Bran data of total flavonoid and total phenolic contents, oxygen radical absorbance capacity and profiles of proanthocyanidins and whole grain physical traits of 32 red and purple rice varieties. *Data in Brief*, 8: 6-13,2016.

[5] Debnath, S., Hemavathya, J. and Bhat, K. K. Moisture sorption studies on onion powder. *Food Chemistry*,78:479-482, 2002.

[6] Daiponmak, W., Senakun, C. and Siriamornpun, S. Antiglycation capacity and antioxidant activities of different pigmented Thai rice. *International Journal of Food Science and Technol*ogy, 49:1805-1810, 2014.

[7] FAOSTAT. 2013. Rice production. http://faostat.org (accessed March 29, 2015).

[8] Fageria, N, K. and Baligar, V,C. Upland rice and allelopathy. *Communications in Soil Science and Plant Analysis*, 34:1311-1329, 2003.

[9] Hach, T. and Ferrannini, E. *The future of anti-diabetics in T2DM therapy*. The significance of the kidney in diabetes, 81-86, 2012.

[10] Jaya, S. and Das, H. Sensory evaluation of mango drinks using fuzzy logic. *Journal of Sensory Studies*, 18:163-176, 2003.

[11] Jha, P., Das, A,J., Dash, K, K. and Deka, S, C. Sensory evaluation of black pigmented rice (*Oryza sativa cv. Poireton*) wine fortified with probiotic Lactobacillus acidophilus ATCC 4356 and Lactobacillus sakei ATCC 15521 using fuzzy logic. *Journal of Institute of Brewing*, 121: 566-573, 2015.

[12] Kadam, D, M. and Balasubramanuan, S. Foam-mat drying of tomato juice. *Journal of Food Processing and Preservation*, 35: 488-495, 2011.

[13] Kudra, T. and Ratti, C. Foam-mat drying: energy and cost analyses. *Canadian Biosystems Engineering*, 48(3): 3.27- 3.32, 2006.

[14] Kang, K., Lim, D.H., Choi, I, H., Kang, T., Lee, K., Moon, E,Y., Yang, Y., Lee, M,S. and Lim, J,S. Vascular tube formation and angiogenesis induced by polyvinyl pyrrolidone coated silver nanoparticles. *Toxicology Letters*, 205: 227-234, 2011.

[15] Kang, M., Kim, J., Rico, C.W. and Nam, S.A. Comparative study on the physicochemical characteristics of black rice varieties. *International Journal of Food Prop*erties, 14:1241-1254, 2015.

[16] Lazim, M, A. and Suriani, M. Sensory evaluation of the selected coffee products using fuzzy approach, *The World Academy of Science, Engineering and Technology*, 50:717-720, 2009.

[17] Ministry of Agriculture. 2008. Government of India.www.indiastat.com Accessed 29 January 2014.

[18] Murdifin, M., Wahyudin, E., Lawrence, Manggau, M, A., Alam,G., Pakki, E., Djabir, Y., Arsyad, A. and Bahar, M, A. Antiatherogenic effect of *Mezzetia parviflora* BECC extract in high cholesterol fed rats. *Journal of Chemical and Pharmaceutical Research*, 7:499-505, 2015.

[19] Patel, S, S. Morphology and pharmacology of *Passiflora edulis*: a review, *Journal of Herbal Medicine and Toxicology*, 3:1-6, 2009.

[20] Ramaiya, S,D., Bujang, J.S., Zakaria, M,H., King,W,S. and Shaffiq, S, M,A. Sugars, ascorbic acid, total phenolic content and total antioxidant activity in passion fruit (*Passiflora*) cultivars. *Journal* of *the Science of Food and Agriculture*, 93(5):1198-205, 2013.

[21] Riaz, M, N. Introduction to extruders and their principles. *In: Extruders in food applications*, CRC Press, Boca Raton, United States of America. P 1- 23, 2000.

[22] Sharma,A., Paliwal, G., Upadhyay, N. and Tiwariet ,A. Therapeutic stimulation of GLP-1 and GIP protein with DPP-4 inhibitors for type-2 diabetes treatment. *Journal of Diabetes and Metabolic Disorders*, 14 (15): DOI 10.1186/s40200-015-0143-4,2015.

[23] Surarit, W., Jansom, C., Lerdvuthisopon, N., Kongkham, S. and Hansaku, P. Evaluation of antioxidant activities and phenolic subtype contents of ethanolic bran extracts of Thai pigmented rice varieties through chemical and cellular assays. *International Journal of Food Science and Technology*, 50:990-998, 2016.

[24] Viswanathan, R., Jayas, D, S. and Hulasare, R,B. Sorption isotherms of tomato slices and onion shreds. *Biosystems Engineering*, 86: 465-472, 2003.

[25] White, B, L., Howard, L, R. and Prior, R, L. Polyphenolic composition and antioxidant capacity of extruded cranberry pomace, *Journal of Agricultural and Food Chemistry*, 58(7): 4037-4042,2010.

[26] Xia, Q., Wang, L., Xu, C., Mei, J. and Li, Y. Effects of germination and high hydrostatic pressure processing on mineral elements, amino acids and antioxidants in vitro bioaccessibility, as well as starch digestibility in brown rice (*Oryza sativa* L.). *Food Chemistry*, 214: 533-542, 2017.