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**DEVELOPMENT OF EXPANDED SNACK
FOODS CONTAINING PUMPKIN FLOUR AND
CORN GRITS USING EXTRUSION
TECHNOLOGY**

A thesis presented in partial fulfilment of the
requirements for the degree of

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Abstract

The production of expanded snack foods using vegetable powder as an ingredient in ready-to-eat food is rare. In view of its natural desirable colour, flavour, sweetness and health benefits, pumpkin was chosen as an additive to the traditional corn grits or rice used as the basis of an extrusion expanded snack or breakfast food concept. Pumpkins also have a large range of uses as a potentially valuable food for humans and animals. However, they are an underutilised product. This study was undertaken to demonstrate the potential of pumpkin products as additives in expanded snack food products. Processing the fresh pumpkin into flour dramatically extends the shelf life and makes the ingredient available throughout the year. The flour is more convenient for extrusion as it is stored and handled as a dry powder. Research was conducted to produce and characterise pumpkin flour made by convection oven and freeze drying of a pumpkin fractions such as peel, pulp (rind), flesh and seed. The flour was combined with corn grits in various proportions up to a maximum of 20% w/w. After determining suitable processing conditions and the maximum acceptable concentration of pumpkin flour for an edible product, the effect of process parameters on product quality were determined. Finally the product was optimised using response surface methodology (RSM). The proximate compositions of pumpkin flour from convection oven and freeze drying were as expected identical to commercial pumpkin flour. The carbohydrate content ranged between 69.8 and 89%, protein ranged between 1.3 and 21%, and fat between 0.03 - 0.53%. Pumpkin flour produced by freeze drying revealed *L*, *a* and *b* values higher than in commercial pumpkin flour, indicating that the flour was lighter in colour and appeared more orange than that oven dried. The effect of varying pumpkin flour proportion at two mass flow rates of 7.5kg/hr and 8.5kg/hr revealed that mass flow rate did not have any significant correlation to the extrusion parameters and the final quality of the expanded snack product. However, a high quality final product can be achieved at all mass flow rates with less than 20% pumpkin flour incorporated into the blend. Varying the proportion of pumpkin flour between 5% and 20% in combination with corn grits using screw speeds of 250rpm and 350rpm showed that, increasing the proportion of pumpkin flour to 20% significantly ($P < 0.05$) decreased specific mechanical energy (SME) and torque. The extruded pellets using a 20% blend of pumpkin with corn grits were harder, more denser and less expanded than those made with higher proportions of corn grits. The crispiness and hardness of the final product was not closely related to the number or area of bubbles present in the structure. Screw speed did not significantly ($P > 0.05$) affect the specific mechanical energy (SME)

or the physical characteristics of the final product. Hardness seemed to be due to bubble wall stiffness i.e. effectively the thickness and rigidity of the set starchy matrix. Response surface methodology (RSM) was predicted four solutions for optimum conditions which can be achieved at barrel temperature ranging from 165°C to 167°C at a constant feed rate of 10.50kg/hr and pumpkin flour percentage ranged from 16% to 17%. With these conditions, the optimum SME of 0.15 was achieved and this product had a maximum radial expansion of 11.00%, hardness less than 142.0N with a total carotenoid content of 2.07ppm to 2.13ppm. Sensory analysis revealed most consumers preferred expanded snack products containing 5% pumpkin flour and produced by extruding at a barrel temperature of 170°C and mass flow rate of 12.0kg/hr. The panellists indicated that they would buy this product due to its acceptable taste, texture, odour and overall product characteristics. However, the expanded snack with 15% pumpkin flour was found to have highest total carotenoid content (5.78ppm) and protein content (28.8%) after processing and may have been, in nutritional terms, the best product. The slowly digestible starch (SDS) value and carbohydrate content of this product was found at 97.03mg/g and 59.29% respectively. From this work useful information regarding pumpkin flour and its application in extruded expanded snack production was obtained. This work has the potential to diversify the application of pumpkin flour and offer new uses for pumpkin in the food industry.

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*Norfezah Md Nor
Autumn 2013*

In Memory

Aminah Hashim (mom)

Nurul Izzah Jaafar (daughter)

Som Mat (grandma)

Omar Osman (father in law)

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List of Peer-Reviewed Publications, Conference Proceedings and Presentation

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Conference Proceedings

Norfezah, M.N., Hardacre, A., Carr, A., & Brennan, C.S. Effect of varying pumpkin flour and screw speed on the extrusion parameters, physical characteristics and microstructure of the development added-value expanded snack products. In *The Proceeding of 44th Annual AIFST Convention "Tackling Tomorrow Today", 10-13 July 2011, Sydney Convention Centre, Darling Harbour, Sydney, Australia.*

Norfezah M.N., Hardacre A.K., Carr A.J., Brennan C.S. The effect of process parameters on the operating conditions and physical properties of extruded breakfast cereals made from pumpkin flour and corn grits. In *The Proceedings of New Zealand Institute of Food Science (NZIFST) Conference : Food Elements-Putting The Pieces Together, 23rd-25th June 2009, Christchurch Convention Centre, Christchurch, New Zealand.*

Norfezah, M. N., Brennan, C.S. & Hardacre, A. Utilization of pumpkin flour in expanded breakfast cereals. In *Total Food Proceeding : Sustainability of the Agri-Food Chain International Conference, K.W.Waldron, G.K.Moates, C.B. Faulds (eds), 22-24 April 2009, Norwich, UK, pp105-108*

Oral presentation

Norfezah, M.N. (2009). Optimization of process parameters for production of extruded snack food made from pumpkin flour and corn grits. (Oral presented at IFNHH Seminar on 19/8/09)