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Proximate Composition and Some Functional Properties of Soft Wheat Flour

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ABSTRACT: The objective of this research was to assess the proximate composition and selected functional properties of soft wheat flour. The commercially available soft wheat flour was purchased from local suppliers at Kajetia market in Kumasi-Ghana. The flour were cleaned of foreign materials and sieved through 75 μm. The flours were packaged in air-tight plastic containers prior to analyses. The flours were analyzed for their proximate composition. The flour functional properties were determined and compared with those of asomdwee cowpea flour. The results showed that the soft wheat flour had higher (1.33%) fat and carbohydrate content (83.60%) than the cowpea flour. The crude protein, fibre, moisture and ash content were all lower in soft wheat flour as compared to the cowpea flour. However, the bulk density, oil and water absorption capacity of the wheat flour were not significantly different from the cowpea flour. Solubility, swelling power and foam capacity of the wheat flours were lower as compared to the cowpea flour.

KEY WORDS: Soft wheat flour, proximate composition and functional properties

I. INTRODUCTION

As human population continued to grow, there is a considerable world wide interest in the utilization of wheat based food products. Comparative analysis of several food products from wheat flour for both human and animal feed is of greater concern [7]. Wheat is the principal cereal widely used for making bread than any other cereal. The protein called gluten makes bread dough stick together and gives it the ability to retain gas [33**]**. Wheat supplies about 20 percent of the food calories for the world's people and is a national staple in many countries. Wheat is the major ingredient in most breads, rolls, crackers, cookies, biscuits, cakes, doughnuts, macaroni, spaghetti, puddings, pizza, and many prepared hot and cold breakfast foods. Much of the wheat used for livestock and poultry feed is a by- product of the flour milling industry [34]. The green forage may be grazed by livestock or used as hay or silage. Industrial uses of wheat grain include starch for paste, alcohol, oil, and gluten. The importance of wheat is mainly derived from the fact that seed can be ground into flour. It also forms the basic ingredient of bread and other bakery products and presents the main source of nutrient to most of the population [36]. Information on the chemical composition and functional properties of wheat flour is lacking in the literature. Thus, the objective of this study was to determine the proximate composition and functional properties of wheat flour.

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II. MATERIALS AND METHODS

2.1 Experimental Locations

Proximate and functional properties were all carried out at the Biochemistry Department of the Crop Research Institute of the Council for Scientific and Industrial Research at Fumesua, Kumasi Ghana.

2.2 Sample Collection and Flour Preparation

The commercially available soft wheat flour was purchased from local suppliers at Kajetia market in Kumasi. The flour were cleaned of foreign materials and sieved through 75 µm. The flours were packaged in air-tight plastic containers prior to analyses.

2.3 Functional Properties Determination

Bulk density of the flour samples was determined as described by [9]. Water and oil absorption capacity was determined by the methods described by [29]. Foam capacity was determined using [35] method. Solubility and swelling power were determined based on a modification of the method of [29]

2.4 Proximate Composition Determination

Moisture content was determined by hot air oven drying at 50°C for 18 hours [8]. Ash Content of flours were determined by ignition of flours for 2hours at 600^0C [8]. Crude fiber and fat (solvent extraction) were determined by the [8] methods. Crude protein content was determined by digestion and distillation of samples. The distillate was titrated against 0.1N hydrochloric acid (HCl) solution until the solution changed from bluish-green to pink [31]. Carbohydrate content was calculated by the difference methods

2.5 DATA ANALYSIS

All data collected were analyzed using Statistix 9 statistical Package. Mean separation was done using LSD at 1% confidence intervals.

III. RESULTS AND DISCUSSION

3.1 Proximate Composition

Table 4.1: Proximate composition of Soft wheat and Asomdwee cowpea flour (%)

Flour Type	Crude protein	Crude fibre	Moisture content	Ash	Fat	Carbohydrate
Soft Wheat	10.23	0.51	3.33	1.00	1.33	83.60
Cowpea	24.53	3.21	10.90	3.00	1.00	57.35
$LSD_{0.01}$	0.75	0.42	1.06	0.20	0.71	1.28
CV	1.66	8.67	4.98	3.95	13.69	0.58

3.1.1 Moisture Content

The moisture content of Asomdwee cowpea was the highest and was significantly ($P < 0.01$) different from soft wheat flour. The moisture content of wheat flour was lower than 11.60% and 13.29% recorded for buckwheat flour and refined wheat flours [13] as well as 13.3% for wheat flour as reported by [4]. The moisture content in this study for cowpea was higher than the (9.20%) for cowpea flours in Nigeria by [10]. The moisture content of wheat flour was within the acceptable limit of not more than 10% for long term storage of flour [39]. Moisture content of foods is influenced by type, variety and storage condition [19]. The low moisture content of wheat flour would enhance its storage stability by avoiding mould growth and other biochemical reactions [39]. [40] reported moisture content of (7.75%) for wheat flour which was quite higher than the moisture content in the soft wheat flour in this research. This assertion explains why they have longer shelf life and also confirms their used in both noodles and bakery products. According to [23], high quality noodles should have an adequate shelf life without any microbiological deterioration and therefore the low moisture content of the soft wheat flours will in the end extend the shelf life of the final product.

3.1.2 Crude Protein Content

The crude protein content of the flour samples ranged between 10.23% and 24.53% (Table 4.1). The protein content of wheat flour reported in this study was found to be lower than the 14.70% [1] and 12.86% [30] for wheat flours. The crude protein content differences can be attributed to the geographical location. Since soils with high nitrogen levels can influence protein levels [14].The protein content of the flours in this study suggests that they may be useful in food formulation systems especially with the Asomdwee cowpea variety. The protein content of asomdwee cowpea (24.53%) was found to be between the range of 20 - 27 % reported by [26] for some cowpea varieties and also close to 21.63- 25.28% for four advanced lines of cowpea reported by [12]. The crude protein content and quality of wheat flours can be improved by blending wheat flours with cowpea flours and used as composite flours.

3.1.3 Crude Fat Content

Soft wheat flour had higher (1.33%) fat content than cowpea (1.00%). [27] had 2.80% and 1.80% fat content for brown rice and refined wheat flours respectively. The fat content of wheat flour from this study was found to be lower than1.5% reported for wheat flour [6]. The differences in fat content may be due to location and varietal differences [31]. Diets with high fat content contribute significantly to the energy requirement for humans. High fat content of soft wheat flour in this study would make it a better source of fat than the cowpea flour. High fat flours are also good for flavor enhancers and useful in improving palatability of foods in which it is incorporated [5].

3.1.4 Ash Content

The ash content of the flours ranged between 1.00 and 3.00% (Table 4.1). The ash content for wheat flours in this study was lower than the 2.53% for mung bean flour and 2.53% for chickpea flour as well as 6.51%, 4.58%, 4.73% and 3.25% for Jack bean, Pigeon pea, cowpea and mucuna bean flour respectively [10]. The ash content (1.40%) of refined wheat flour [27] was close to 1.00% wheat flour reported for these studies. Ash content is an indication of mineral content of a food. This therefore suggests that Asomdwee cowpea flour could be important sources of minerals than wheat flours. Ash content in wheat flours can be improved if cowpea is incorporated.

3.1.5 Crude Fiber Content

[27] reported 1.23% for brown rice flour and 0.85% refined wheat flour. The crude fibre content of 0.51% recorded for wheat in this research was quite close to the 0.85 % reported by [27]. Asomdwee cowpea flour had the highest crude fibre content (3.21%). [16] reported crude fiber content of 8.19% for pigeon pea, 9.58% cowpea, 4.61% mungbean and 6.83% for peas flour. These were all higher than the crude fibre obtained for the two flours in this research. Crude fibre helps in the prevention of heart diseases, colon cancer, diabetes etc. Wheat flour would not be a better source of fibre content since it had significantly lower crude fibre content. Therefore, it will be useful if cowpea is added to it and used in food formulation to help relieve constipation.

3.1.6 Carbohydrate Content

The carbohydrate content of the flours varied from 57.35% to 83.60%. Wheat flour had the highest carbohydrate content (83.60%). The carbohydrate content of the flours for cowpea and wheat flours was comparable to 57.17% for cowpea, 74.22% for wheat; reported by [4]. Carbohydrate content of 50.95% to 53.98% reported for Nhyira, Tona and Adom cowpea varieties were within the ranges recorded in this research [9]. [20] recorded lower range (34.97 to 39.86%) carbohydrate content for three soya bean varieties. It can be observed that the flours used for these studies had higher carbohydrate content. The high carbohydrate content of wheat flour suggests that it could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy [15]. Carbohydrates are good sources of energy and that a high concentration of it is desirable in breakfast meals and weaning formulas. In this regard therefore, the high carbohydrates content of the wheat flour would make it a good source of energy in breakfast formulations [15]

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Table 4.2 Functional properties of flours of cowpea and soft wheat

Parameter	Asomdwee Cowpea flour	Wheat flour	$LSD_{0.01}$	CV
BD (g/cm^3)	0.82	0.71	0.04	2.10
OAC (%)	1.48	1.00	0.13	3.33
WAC (%)	2.27	1.50	0.63	13.58
FC (%)	19.00	13.20	1.97	4.38
SOLB (%)	27.26	15.91	4.19	7.40
SP (%)	12.11	7.50	2.04	6.89

Note: BD- Bulk density; OAC – Oil absorption capacity, WAC – Water absorption capacity; FC- Foam capacity; SOLB – Solubility; SP – Swelling power

3.2. Functional Properties

3.2.1 Bulk Density

The bulk densities obtained in this research were lower than those reported by [20] for three soya beans varieties in Ghana (1.56 to 2.09g/cm^3) however; the bulk densities obtained were also found to be higher than six improved commercial chicken pea cultivars in India with bulk densities ranging from 0.55 to 0.57g/cm^3. Bulk densities of 0.85±0.01 and 0.68±0.00 g/cm^3 reported by [27] for brown rice flour and refined wheat flour were similar to the results obtained from this research. According to [9] bulk density is a function of particle size, particle size being inversely proportional to bulk density. Particle size differences may be the cause of variations in bulk density of the flours. The particle size also influences the package design and could be used in determining the type of package material required. Higher bulk density is desirable since it offers greater packaging advantage as greater quantity of flour can be packed within a constant volume [27].

The bulk density of the flours could be used to determine their handling requirement, because it is the function of mass and volume [37]. Bulk density is also important in infant feeding where less bulk is desirable. Since soft wheat flour was the least dense it would occupy greater space and therefore would require more packaging material per unit weight and so could have high packaging cost [38] however, soft wheat flour would be easier to transport as it was lighter. The low bulk density of wheat flour would be an advantage in the use of the flour for preparation of complementary foods. The low bulk density of soft wheat flour could be attributed to the relatively lower protein content and moisture content [37].

3.2.2 Oil Absorption Capacity

Oil absorption capacity is attributed mainly to the physical entrapment of oils. It is an indication of the rate at which the protein binds to fat in food formulations [39]. The lower oil absorption capacity of soft wheat could be due to low hydrophobic proteins which show superior binding of lipids [3]. The Oil absorption capacity of cowpea flour in this study was lower than that (1.95 to 2.14ml/g) reported for Nhyira, Tona and Adom cowpea varieties [9]. [41], reported oil absorption capacity of 1.05 to 1.17 ml/g for six improved commercial chicken pea cultivars. Oil absorption capacity values of 1.13, jack bean, 1.48 pigeon pea and 1.13ml/g cowpea were in accordance with the results obtained in this research [10]. Higher oil absorption capacity of 1. 96 and 1.61 ml/g were reported for brown rice flour and refined wheat flour [27]. These values were found to be higher than those obtained in these studies. The relatively high oil absorption capacity of cowpea flour suggests that it could be useful in food formulation where oil holding capacity is needed such as sausage and bakery products [4]. This shows that cowpea flour would be useful in this respect than wheat since it had significantly higher oil absorption capacity.

3.2.3 Water Absorption Capacity

The cowpea flour had higher (2.27%) water absorption capacity than wheat flour (1.50%). The water absorption capacities of the flours were comparable to that of full fat flours in six mucuna species (1.2 to 2.00 g/g) reported by [2]. The water absorption capacities of the flours under study were found to be higher than 0.32 g/g for wheat, 1.68 g/g maize and 0.89 g/g cowpea reported by [37]. [3] reported water absorption capacity value of 2.45g/g for wheat flour, which was higher than the one under study. [41] reported water absorption ranges of 1.34 to 1.47g/g in some chicken pea cultivars. Water absorption capacity represents the ability of the products to associate with water under conditions when water is limiting such as dough's and pastes. The result of this study suggests that cowpea would be useful in foods such as bakery products which require hydration to improve handling features [7].

3.2.4 Foam Capacity

Foam capacity is the ability of substance in a solution to produce foam after shaking vigorously Proteins foam when whipped because they are surface active [41]. The foaming properties are used as indices of the whipping features of protein isolates [9]. This explains why cowpea had higher foam capacity; since it recorded the highest crude protein content (Table 4.1). The foam capacity of wheat flour obtained in this research (3.00%) was lower than the 4.12% for wheat flour reported by [3]. The foam capacity (19.00%) obtained for cowpea flour was higher than cowpea protein isolate (6.95%) reported by [16] as well as 3.45% reported for cowpea by [17].

3.2.5 Solubility

Solubility values of 14.31 and 17.99% reported by [20] on three soya bean varieties as well as 7.30% and 11.5% for fermented and unfermented *A. altilis* by [9] were all within the range of the flours under study. According [16] solubility of protein isolate for cowpea was 6.54%. This was quite lower than the solubility reported for cowpea flour in this research. [22] reported solubility of 8.63% for wheat flour in contrast to the 15.91% obtained in this work. The presence of lipids could result in reduced water absorption capacity of flours which may lead to reduced swelling and consequently reduced solubility [28]. This assertion explains the reason for the high solubility in cowpea flour than wheat flour. The high solubility of asomdwee cowpea flour suggests that it was more digestible and therefore could be suitable for use as ingredient in infant food formulations.

3.2.6 Swelling Power

The swelling power of the flours varied between 7.50 and 12.11%. The observed values were lower than wheat flour (12.75%) reported by [18], however; the values obtained were also higher than (4.25 to 4.66%) reported by [20] on some soya bean varieties. The values in this research were higher than the ranged 2.65 to 2.68% reported for Tona, Nhyira and Adom respectively by [9]. [28] reported higher swelling power values of 16.04 and 16.98% for brown rice flour and refined wheat flour respectively. The gelatinization and swelling power test provided suitable predictive method for identifying noodle-quality flours [21] Formation of protein-amylose complex in native starches and flours may be the cause of decreased in swelling power. The extent of swelling depends on the temperature, availability of water, species of starch and other carbohydrates and proteins [40] According to [21] increase in water absorption capacity increases the swelling power leading to an improved solubility. This is in agreement with the high swelling power in the cowpea flour than the others. The high swelling power suggests that cowpea flours could be useful in food systems where swelling is required.

IV. CONCLUSION

This study has characterized the proximate and functional properties of soft wheat flour. The flour contained higher contents of fat and carbohydrate content. Bulk density, Oil and water absorption capacity for the wheat flours were quite similar to that of the cowpea flours. Foam capacity, solubility and swelling power was significantly higher in cowpea flours than in the wheat flours. However, the various functional tests showed that wheat flour has the potential for incorporation into food formulations as a functional ingredient.

REFERENCES

1. Adams, M.L., Lombi, E., Zhao, F.J. and McGrath, S.P. "Evidence of low selenium concentrations in UK bread-making wheat grain" *Journal of the Science of Food and Agriculture*, Vol. 82 pp. 1160–1165, 2002.

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2. Adebowale, Y.A., Adeyemi, I.A. and Oshodi, A.A., "Variability in the physicochemical, nutritional and anti-nutritional attributes of six Mucuna species" Food Chemistry. Vol. 89 pp. 37-48, 2005.
3. Adeleke, R.O. and Odedeji, J.O., "Functional Properties of Wheat and Sweet Potato Flour Blends" Department of Food Technology, Osun State Polytechnic, Iree, Osun State, Nigeria, 2010.
4. Ahmed, A.M. and Lydia J. Campbell J.L., "Evaluation of Baking Properties and Sensory Quality of Wheat-Cowpea Flour" World Academy of Science, Engineering and Technology 70, 2012.
5. Aiyesanmi, A. F. and Oguntokun, M. O., "Nutrient composition of Dioclea reflexa seed an underutilized edible legume" Rivista Italiana delle Sostanze Grasse. Vol. 73 pp. 521–523, 1996.
6. Akpapunam, M.A. and Sefa-Dedeh, S., "Jack bean (*Canavalia ensiformis*) Nutrition related, Aspects and Needed Nutrition Research", *Journal of Plant Food for Human Nutrition*, Vol. 10 pp. 123-127, 1997.
7. Anonymous, "A Guide to Understanding Wheat and Flour Quality", Version 2, Kansas State University, 2008.
8. AOAC "Official Methods of Analysis", Association of Official analytical Chemists 17thEdition, Washington D. C., 2002.
9. Appiah, F., Asibuo, J.Y and Kumah, P., "Physical and functional properties of bean flours of three cowpea (Vigna unguiculata L. walp) varieties in Ghana", *African Journal of Food Science*. Vol. 5(2), pp. 100-104, 2011.
10. Arawande .J.Olalekan and Borokini .F. Bosede, "Comparative Study on Chemical Composition and Functional Properties of Three Nigerian Legumes (Jack Beans, Pigeon Pea and Cowpea)" Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 89-95, 2010. © Scholarlink Research Institute Journals
11. Asare, T. A., Agbemafle, R., Adukpo, G. E., Diabor, E. and Adamtey, K.A., "Assessment of Functional Properties and Nutritional Composition of Some Cowpea (*Vigna Unguiculata L.*) Genotypes in Ghana", Department of Molecular Biology and Biotechnology, School of Biological Sciences, University of Cape Coast, Cape Coast, Ghana, 2013.
12. Baljeet, S.Y, Ritika, B.Y. and Roshan, L.Y., "India Studies on functional properties and incorporation of buck wheat flour for biscuit making" Department of Food Science and Technology Chaudhary Devi Lal University, Sirsa (Haryana) – *International Food Research Journal*, Vol. 17 pp. 1067-1076, 2010.
13. Blumenthal, J., Baltensperger, D., Cassman, K. G., Mason, S. and Pavlista, A., "Importance and Effect of Nitrogen on Crop Quality and Health", Agronomy -- Faculty Publications. Paper 200, 2008. http://digitalcommons.unl.edu/agronomyfacpub/200. Accessed September 1, 2012
14. Brown, K. H., "The importance of Dietary Quality versus Quantity for weanlings in the developed countries", A Framework for Discussion. *Food and Nutrition Bulletin*. 13 (2): 86-93, 1991.
15. Butt and MS Batool R., "Nutritional and Functional Properties of Some Promising Legumes Protein Isolates", Pak, J. Nutri. 9(4): 373-379, 2010.
16. Chinma, C. E. and Gernah, Z. D. I., "Physicochemical and Sensory Properties of Cookies Produced from Cassava/Soyabean/Mango Composite Flours", *Mexiwen Journal of Food Technology* 5 (3): 256-260, 2007.
17. Duranti, M., "Grain legume proteins and nutraceutical properties", *Fitoterapia* Vol. 77, pp. 67–82, 2006.
18. Enwere N.J., "Foods of Plant Origin", Afro-orbis publishers, Nsukka, Nigeria.pp 124-145, 1998.
19. Eshun, G., "Nutrient composition and functional properties of bean flours of three soya bean varieties from Ghana", Department of Home Economics Education, Faculty of Science Education, University of Education, Winneba, 2012.
20. Ezema, "Effect of heat on in-vitro digestibility of navy beans (P.vulgaris)", Michigan Quaterly Bull 46: 87, 1989.
21. Flodin, N.W., "The metabolic roles, pharmacology, and toxicology of lysine", The Journal of the America College of Nutrition, Vol. 16(1) pp. 7-21, 1997.
22. Fu, B. X., "Asian noodles: History, classification, raw materials, and processing", *Food Research International*, 41(9), 888-902, 2008.
23. Haard, N.F. and Chism, G.W., "Characteristics of edible plant tissues, Food Chemistry", New York: Marcel Dekker, Inc. pp. 943–1001, 1996.
24. Henshaw, F.O., "Varietal Differences in Physical Characteristics and Proximate Composition of Cowpea (*Vigna unguiculata*)" Department of Food Science and Technology, University of Agriculture, *Nigeria World Journal of Agricultural Sciences* Vol. 4 (3), pp. 302-306, ISSN 1817-3047, 2008.
25. Islam, M. Z., Taneya, M. L.J., Shams-Ud-Din, M., Syduzzaman, M. and Hoque, M. M., "Physicochemical and Functional Properties of Brown Rice (Oryza sativa) and Wheat (Triticum aestivum) Flour and Quality of Composite Biscuit Made Thereof" Retrieved from http://fst.sagepub.com/content/15/4/325, 2:45pm, November 2012. *Food Science and Technology International*, Vol. 15 p. 325, 2012.
26. Jayasena, V., Leung P. and Nasar-Abbas S. M., "Development and Quality Evaluation Of Lupin-Fortified Instant Noodles", Food Science and Technology, School of Public Health, Curtin University of Technology, Perth, Australia, 2008.
27. Leach HW, McCowen LD, Scoch T.J., "Structure of starch granule Swelling and solubility patterns of various starches", *Cereal chem*., 36: 534-544, 1959.
28. Mepba, H. D., Eboh, L., & Banigo, D. E. B., "Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables" *Afr. J. Food Agric. Nutr. Dev.*, *7*(1), 1-18, 2007.
29. Moorthy, S. N., Rickard, J. and Blanshard, J. M. V., "Influence of gelatinization characteristics of cassava starch and flour on the textural properties of some food products", Colombia, pp. 150-155, 1996.
30. Morris, M.L., Tripp, R. and Dankyi. A. A., "Adoption and Impacts of Improved Maize Production Technology: A Case Study of the Ghana Grains Development Project Economics Program", No 99-01, Mexico, D.F., 1999.
31. Moss, R., Gore, P.J. and Murray, I.C., "The influence of ingredients and processing variables on the quality and microstructure on Hokkien, Cantonese and instant noodles" Food Microstructure. Vol. 6, 63-74, 1987.
32. MOST, "Instant Noodles: A potential vehicle for micronutrient fortification: The USAID Micronutrient Program", Roche Pharmaceuticals. Fortification Basics, 2005.
33. Narayana, K and Narasimga, R. N. M. S., "Functional properties of raw and heat processed winged bean flour", *Journal of Food Science* 47: 1534-1538, 1982.
34. Oh, N.H., Seib, P.A., Ward, A.B., and Deyoe, C.W. Noodles. Ⅳ., "Influence of flour protein, extraction rate, particle size, and starch damage on the quality characteristics of dry noodles", *Cereal Chemistry Journal*, Vol. 62 pp. 441-446, 1985.
35. Oladunmoye, Lineback, D.R. and Ke, C.H., "Evaluation of some properties of wheat, cassava, maize and cowpea flours for bread making. Starches and low-molecular -weight carbohydrates from chick pea and horse bean flours" Cereal Chemistry, Vol. 52 pp. 334-347, 2010.
36. Oluwatooyin, F. and Osundahunsi, "A preliminary study on the use of tempe-based formula as a weaning diet in Nigeria", *Plant Foods for Human Nutrition*, Vol. 57 (3-4) pp. 365-376, 2002.
37. Owen, G., "Cereal Processing Technology. Cambridge: Wood head Publishing, 2001.
38. Shittu, O. K. and Tanimu, M., "Proximate analysis of wheat supplemented diet and its anti-trypanosomal effect on infected rat", IJABR Vol. 4(1&2) pp. 109 – 103, 2012.
39. Singh, A., Hung, Y., Corredig, M., Phillips, R. D., Chinnan, M. S. and McWatters, K. H., "Effect of milling method on selected physical and functional properties of cowpea (*Vigna unguiculata*) paste", *International Journal of Food Science and Technology*, Vol. 40, pp. 525-536, 2005.
40. Sui, Z., Lucas, P.W. and Corke, H., "Optimal cooking time of noodles related to their notch sensitivity", *Journal of Texture Studies*. Vol. 37, pp. 428–441, 2006.
41. Tongpun, N., "Formulation of soy protein-enriched instant noodles", Master Thesis of Science [Nutrition], Faculty of Graduate Studies, Mahidol University, Bangkok, Thailand, 2006.