International Journal of Food, Nutrition and Public Health, Vol. 4, No. 2, 2011

DEVELOPMENT OF FUNCTIONAL DRINK BASED ON FOAM-MAT DRIED PAPAYA (CARICA PAPAYA L.): OPTIMISATION OF FOAM-MAT DRYING PROCESS AND ITS FORMULATION

Theresia Endang Widoeri Widyastuti[1] and Ignatius Srianta[2]
Widya Mandala Surabaya Catholic University, Indonesia

Abstract: Constipation is a common public health problem nationally and internationally. Most constipation sufferers would prefer regular intake of some natural food-stuff that prevents the disorder rather than over-the-counter remedies. Papaya (Carica papaya L.) fruit is usually consumed to prevent and manage constipation because it has laxative effect. Development of functional drink based on foam-mat dried papaya has been done. First step was optimisation the foam-mat drying process. Papaya slurry was foamed by adding egg white of 10%, 15% and 20% w/w. The foamed papaya slurry was dried by using hot air drying method at 60°C for 5 hours. Drying yield increased with increasing of egg white concentration. Moisture content, reconstitution and water holding capacity of the products were in range from 2.91 to 3.09%, from 81.34 to 83.42% and from 6.19 to 6.34 g/g, respectively. The second step was formulation of functional drink based on foam-mat dried papaya. Foam-mat dried papaya was dry blended with other ingredients at different ratio of foam-mat dried papaya and skim milk powder of 6:4; 5:5; 4:6 w/w. The different ratio of foam-mat dried papaya and skim milk powder affected the physico-chemical properties (moisture content, reconstitution, viscosity, turbidity, water holding capacity and stability) and sensory properties (colour, viscosity, aroma and taste) of the product. Consuming of the formulated-product twice a day could supply 9.54% of recommended daily intake of dietary fiber. The developed product has a great potential as a functional drink to prevent and manage constipation.

Keywords: *functional drink, papaya, foam-mat drying, egg white, formulation, constipation*

INTRODUCTION

Constipation is a common public health problem with a well-recognized to cause discomfort and to affect quality of life, which increase during aging. Indication for constipation are given when there are less than three bowel movements per week, less than

[1] Corresponding author: Center for Food and Nutrition Research, Widya Mandala Surabaya Catholic University, Jl Dinoyo 42-44 Surabaya, 60265. Indonesia. Email: srianta_wm@yahoo.com, phone +6231-5678478 ext 118/110, fax +6231-5610818
[2] Department of Food Technology, Faculty of Agricultural Technology, Email: widoeri@ymail.com, phone +6231-5678478 ext 186/110, fax +6231-5610818

copyright © 2011 WASD

35 g of stool per day, stool water weight is less than 70% and gastrointestinal transit time is longer than five days. Based on epidemiology studies of constipation, it is estimated that 12-27% of population in the world suffers from constipation depending on demographic factors. Constipation arises from a variety of causes e.g. chemical compounds such as morphine, dietary habits, and psychological stress. In the United States, it results in more than 2.5 million visits to physicians, 92,000 hospitalizations, and laxative sales of several hundreds million dollars a year (You et al., 2010; Peppas et al., 2008; Higgins and Johanson, 2004**;** Jun et al., 2006; Kakino et al., 2010; Klaschik et al., 2003; Lembo and Camilleri, 2003). 20-30% of people over the age of 60 use a laxative more than once a week. Drugs containing magnesium oxide or sennoside are typically administered for treatment of constipation due to their powerful laxative activities, but these drugs also induce severe diarrhea as a side effect. Most constipation sufferers would prefer regular intake of some natural food-stuff that prevents the disorder rather than over-the-counter remedies (Kakino et al., 2010; Rush et al., 2002). Papaya fruit is one of fruits which have been traditionally consumed to prevent and manage of the constipation.

Papaya (*Carica papaya* L.) is one of the major fruit crops cultivated in tropical and sub-tropical countries. In the year of 2008, worldwide papaya production was more than 9.09 million tonnes (FAO, 2010[a]). Of this production quantity, 44% was produced in Asia (mainly in India and Indonesia), 40% in America (mainly in Brazil), 16% in Africa and the rest in Oceania and Europe (FAO, 2010[b]). Papaya consists of approximately 10% of carbohydrates in the form of fibers, sugars and starches. It is also rich in natural vitamins and minerals (Widyastuti et al., 2003). Previous research showed that papaya fruit provide laxative effect (Widyastuti et al., 2008). Papaya has very poor keeping quality since it contains approximately 88% of moisture and its skin is thin. Post harvest losses of papaya in the range of 40-100% have been reported in developing countries (Teixeira da silva et al, 2007). Drying is a solution offered to overcome the post harvest losses, increase the shelf life, simplify the storage and enlarge the application.

Foam-mat drying is a drying method with the main advantages of lower temperature and shorter drying times, compared to the non-foamed material in the same type of the dryer. A shorter drying time can primarily result from the larger surface area exposed to drying air, but also from particularities of heat and mass transfer in foamed materials (Ratti and Kudra, 2006; Muthukumaran, 2007; Rajkumar et al, 2007). Foam-mat drying techniques have been used to dry various fruits such as pineapple (Beristain et al, 1991), passion fruit (Jossy, 1999), apple (Raharitsifa et al, 2006), apricot (Komes et al, 2005) and mango (Rajkumar et al, 2007; Rajkumar and Kailappan, 2006). The liquid or semi solid of fruit slurry is made into foam with the addition of foaming agents. Egg white was generally used to foam the fruit pulp because of its good foaming properties (Ramaswamy dan Marcotte, 2006), which are due to egg white proteins ability to encapsulate and retain air (Lomakina and Mikova, 2005). Increasing of egg white concentration resulted higher rates of drying as the surface area was higher. The optimum concentration of egg white depends on the type of fruit will be dried.

Aroma and taste of papaya fruit is commonly disliked by consumer, which is still remained in the dried papaya. So, it is need to develop a suitable formulation to improve the aroma and taste of functional drink based on foam-mat dried papaya. The goal of our research is to develop a functional drink based on foam-mat dried papaya with laxation effect as an alternative to prevent and manage constipation, a common public health problem.

The objectives of this research were:

1. to optimize foam-mat drying process of papaya, and
2. to study the effect of product formulation on the physicochemical and sensory properties.

MATERIALS AND METHODS

Materials

Papaya fruit of Thailand variety were used and obtained from papaya plantation in Kediri, East Java, Indonesia which harvested on about 18 months after flowering. The characteristics of papaya was firm ripe stage with uniform color (1/3 part of it is orange). Papayas were peeled, removed the seed, cut in small cube (3x3x3 cm) and stored in a freezer to keep the quality until foaming and drying studies were conducted. Leghorn eggs of 2 days old were procured in Surabaya, Indonesia. α-amilase from pancreatic hog (Fluka), pancreatine from pancreatic porcine (Sigma), pepsin (Fluka), petroleum eter (Merck), etanol (Merck), aseton (Merck), NaOH (Merck), $CuSO_4.5H_2O$ (Merck), Na_2CO_3 (Merck), Citric Acid (Merck), KI (Merck), H_2SO_4 (Merck), KIO_3 (Merck), HCl (Merck), $Na_2S_2O_3$ (Merck), Na_2PO_4 (Merck), amylum (Merck) were purchased from local distributor in Surabaya, Indonesia.

Foam-mat drying of papaya

Foam-mat drying of papaya consists of two main steps. The first is foaming of papaya slurry by addition of egg white at different concentration and the second is drying of foamed papaya slurry in a hot air dryer. Freeze papaya cubes were thawed and then crushed using a pasta maker (Miyako) at speed 2 for 2 minutes, then speed 3 for 4 minutes. Leghorn egg white was foamed in two steps using mixer (Black & Decker). First step, called as foamy stage, was carried out by using mixer speed 3 for 1 minute. Then, dextrin of 0.5% was added into the foam. After that, second step is foaming with using mixer speed 5 for 8 minutes until stiff peak stage. Egg white was used at different concentration: 10, 15 and 20%. Then the foam weighed and mixed with papaya slurry using mixer speed 1 for 1 minute. Foaming properties i.e. density, expansion and stability were determined. 85 g of the foamed papaya slurry was spreaded on the aluminium trays of size 40 x 40 cm and dried using hot air drying at 60°C for 5 hours in a batch type cabinet dryer. At the end of drying, the trays were taken out of the drying chamber for removing of foam mat dried papaya flake. The foamed mat dried papaya flakes yield and properties (moisture content, reconstitution and water holding capacity) were determined. The drying yield was calculated of foam mat dried papaya divided by foamed papaya slurry. The foam-mat dried papaya with the best characteristics was analyzed for total dietary fiber, soluble dietary fiber and insoluble dietary fiber.

Product formulation

Functional drink was formulated by dry blending of foam-mat dried papaya, skim milk, Na-CMC and sugar at different ratio of foam-mat dried papaya and skim milk of 6:4; 5:5; 4:6 w/w. Dry-blending was carried out by using dry blender at speed scale of 1 for 1 minute, then at speed scale of 2 for 2 minutes. The dry-blended product was wrapped within flexible multilayer packaging. Dry-blended products were analyzed for moisture content, water holding capacity, and reconstitution rate. The reconstituted drinks were analyzed for viscosity, turbidity and stability, and sensory properties.

Analysis of foaming Properties

The density of the foamed papaya slurry was determined in terms of mass by volume and represented as g/cm3 (Falade et al, 2003). Foam expansion was carried out by papaya slurry with egg albumen foam was foamed to get maximum foam expansion with minimum density as described by Durian (1995). Stability of foamed papaya slurry was determined by taking 40 g of foamed slurry in a transparent graduated beaker and let it at room temperature for 3 hours. The reduction in foam volume was measured as an index for the foam stability every 30 minutes (Akiokato et al, 1983):

Analysis of foam-mat dried characteristics

The moisture content of papaya flakes in each experiment was determined by using vacuum oven drying with reference the constant dry-weight of the flakes (AOAC, 1997). Water holding capacity were determined by taking 1 g of papaya flakes then added 10 ml of water, vortexed and sentrifuged it at 3500 rpm for 30 minutes. Volume of water fractions were measured (Fardiaz et al, 1992). The reconstitution of papaya flakes were determined by taking 1 g (analytical weight, W_0) of papaya flakes then mix into 100 ml of water using magnetic stirrer for 3 minutes, after that the mixture was filtered using filter paper. The weight of insoluble fractions (W_{if}) was measured. The reconstitution was calculated by formula: Reconstitution = $((W_0-W_{if})/W_0)$ x 100%. Foam-mat dried papaya with the best characteristics was analyzed for total dietary fiber, soluble dietary fiber and insoluble dietary fiber by using enzyme gravimetric method (Asp et al, 1983).

Analysis of formulated-product characteristics

Analysis of moisture content, water holding capacity, and reconstitution rate of formulated-product was similar to the above mention for foam-mat dried papaya. Viscosity of reconstituted formulated-product was measured by using viscometer (Brookfield model DV-E), turbidity was measured by turbidimeter (portable turbidimeter Orbeco-Hellige) and stability was determined by measuring the turbidity after the product left at certain time (0; 2; 4; 6; 8 and 10 minutes). The sensory evaluation of the reconstituted product were done by 100 untrained panelists. Hedonic method was used with line scale of left side represent dislike extremely to right side represent like extremely. The panelists were requested to evaluate the taste, aroma and colour of the soycorn milk. The test was conducted in sensory evaluation room. The scale was measured by ruler from the left side of line.

Statistical analysis

All the experimental treatments were conducted in three replicates. The experimental data were analyzed by using one way analysis of varians (Anova) and mean comparison using Duncan's Multiple Range Test at 95% confidence level. The statistical software SPSS (version 9, SAS, USA) was used.

Table 1: Foaming properties of foamed papaya slurry at different egg white concentration

Egg white (%)	Foaming properties*)		
	density (g/cm^3)	Expansion (%)	Stability (%)
10	0,65^c	54.16^a	100^a
15	0,58^b	60.76^b	100^a
20	0,52^a	75.16^c	100^a

*)Means value with the different alphabets in the column are significantly different ($p > 0.05$)

RESULTS AND DISCUSSION

Optimisation of foam-mat drying process

Table 1 showed the density, expansion and stability of foamed papaya slurry at different egg white concentration.

The density of foamed papaya slurry were varied which close and within the range of highly suitable for foam mat drying (0.2 to 0.6 g/cm^3) (Hart et al, 1967). The foam density was decreased with higher concentration of egg white. Rajkumar et al (2007) reported the similar result, which the density of foamed mango pulp decreased as higher egg white concentration. These results indicate that higher concentration of egg white causes higher air volume entrapped in the slurry. Meanwhile, an increase in foam expansion was occurred when the egg white addition was increased from 10% to 20%. Egg white of 20% produced foamed papaya slurry with highest foam expansion. The higher concentration of egg white produce the higher protein content of the mixture, therefore higher protein molecules act to form cohesive viscoelastic film by the ability to rapidly adsorb on the air-liquid interface during whipping. Globulins are excellent foam formers, but foaminess is significantly affected by the protein interactions with ovomucin, lyzozyme, ovomucoid, ovotransferrin and ovalbumin (Lomakina and Mikova, 2005). Foam stability in all treatments was 100% until 3 hours measurement. It reflect the good performance of proteins contained in egg white e.g. ovomucin. According to Sikorski (2002), hydrophilic amino acids are the major amino acids of ovomucin i.e. asparagines, glutamine, serine, threonine, tyrosine and cystein. Hydrophilic groups of amino acids lowered surface tension at interface of liquid and gas which layered on the foam.

Table 2 showed the characteristics of foam-mat dried papaya at different egg white concentration. Higher concentration of egg white produced higher drying yield, addition of 20% of egg white resulted highest drying yield. This might be related to the highest foam expansion of papaya slurry, hence the porosity of foamed papaya slurry are higher, which caused lower surface area of the mat which adhered to the surface of the trays. Moisture content of foam mat dried papaya produced varied between 2.91 % and 3.09 %. Moisture content of foam-mat dried papaya at different concentration of egg white was not significantly different. This might be due to the hot air drying produce high stability of foamed papaya slurry during drying process.

Table 2: Foam-mat dried papaya properties at different egg white concentration

Egg white (%)	Drying yield (%)	Moisture content (%)*)	Reconstitution (%)*)	Water holding capacity (g/g) *)
10	9.94[a]	3.07[a]	83.42[c]	6.19[a]
15	9.93[a]	2.91[a]	82.84[b]	6.33[a]
20	10.44[b]	3.09[a]	81.34[a]	6.34[a]

*)Means value with the different alphabets in the column are significantly different (p > 0.05)

Reconstitution of papaya flakes were no significant different with different concentration of egg white, which varied between 81.34 and 83.42%. Water holding capacity of papaya flakes varied between 6.13 – 6.34 g/g. Those data reflect the potentiality of this product as an ingredient of beverage and food product. Based on the product properties, 20% of egg white produced foam-mat dried papaya flakes with the best properties. It contains 16.78% (dry basis) of dietary fiber, which consists of 10.54% (dry basis) of insoluble dietary fiber and 6.24% (dry basis) of soluble dietary fiber.

Characteristics of formulated product

Table 3 showed the physicochemical properties of formulated-product at different ratio of foam-mat dried papaya and skim milk. Different ratio of foam-mat dried papaya and skim milk affected significantly of reconstitution rate, but not for moisture content, water holding capacity and viscosity. Higher skim milk proportion, reconstitution rate was higher. It might be due to the skim milk has higher wettablity and dispersibility than foam-mat dried papaya since its particle size is smaller than the foam-mat dried papaya.

Figure 1 showed the turbidity and stability after the formulated-product was reconstituted. Turbidity of reconstituted formulated-product was also affected significantly by different ratio of foam-mat dried papaya and skim milk. It might be related to the composition of foam-mat dried papaya which is rich in insoluble dietary fiber and denatured albumin, commonly occured at 56°C (Cheftel et al, 1985).

Table 3: Formulated-product properties at different ratio of foam-mat dried papaya and skim milk

Ratio	Moisture content (%)*)	Reconstitution rate (second)*)	Water holding capacity (g/g) *)	Viscosity (cP)
6:4	2.88[a]	77.84[c]	0.86[a]	151.33[a]
5:5	2.83[a]	58.00[b]	0.64[a]	150.88[a]
4:6	2.85[a]	35.17[a]	0.48[a]	150.65[a]

*)Means value with the different alphabets in the column are significantly different (p > 0.05)

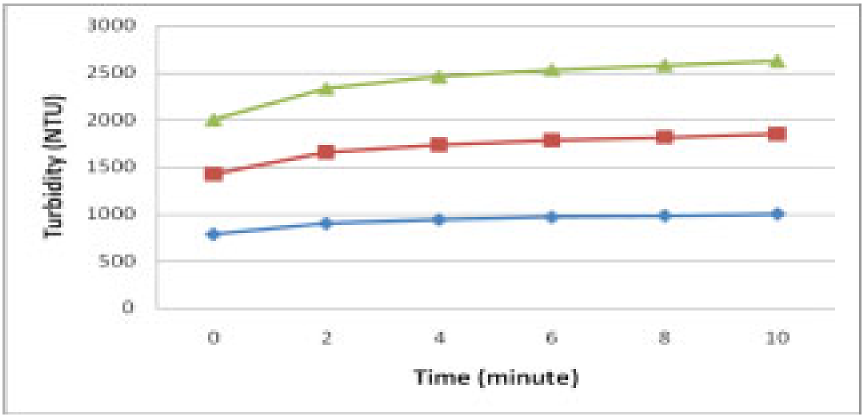

Figure 1. Stability of reconstituted formulated-product at different ratio of foam-mat dried papaya and skim milk
(▲ 6:4; ■ 5:5; ◆ 4:6)

Result of sensory evaluation showed that using of skim milk in the formulation was successfully improve the aroma and taste of foam-mat dried papaya. Preference of aroma and taste scores was higher at higher proportion of skim milk (Table 4) with highest score at ratio of foam mat dried papaya:skim milk of 4:6.

Table 4: Sensory properties of formulated-product at different ratio of foam-mat dried papaya and skim milk

Ratio	Colour	Viscosity	Aroma	Taste
6:4	3.66[a]	4.13[a]	3.98[a]	4.31[a]
5:5	4.58[c]	4.03[a]	4.64[b]	4.73[b]
4:6	4.18[b]	4.16[a]	4.69[b]	5.02[c]

[*)]Means value with the different alphabets in the column are significantly different ($p > 0.05$)

At ratio of foam-mat dried papaya and skim milk of 4:6, the formulated product contain total dietary fiber, soluble dietary fiber and insoluble dietary fiber were 2.98%, 0.26% and 2.72% (wet basis), respectively. Dietary fibers analysis could be used to estimate laxative components of the formulated-product. With assumption of serving size of 40 grams of formulated product which was reconstituted in 200 mL of water, the product could supply total dietary fiber of 1.20 grams. Consuming of the formulated-product twice a day could supply 9.54% of recommended daily intake of dietary fiber, 25 grams per day (Damodaran et al., 2008). The developed product has a great potential as a functional drink to prevent and manage constipation, a common public health problem.

CONCLUSIONS

Foam-mat drying of papaya at egg white level of 20% produced the best characteristics of foam-mat dried papaya. Formulated-product at ratio of foam-mat dried papaya and skim milk of 4:6 provide the best physicochemical and sensory properties. Consuming of twice a day of the formulated-product could supply 9.54% of recommended daily intake of dietary fiber. The developed product has a great potential as a functional drink to prevent and manage constipation. Further research on assessment laxative effect of the developed product in human is recommended.

ACKNOWLEDGEMENT

Thanks to Directorate General of Higher Education, Department of National Education, Republic of Indonesia for research financial through Competitive Research Program of Hibah Bersaing Batch XIV. Thanks to Irma Soetanto and Benny Kurniawan for technical supporting to this research project.

BIOGRAPHY

Theresia Endang Widoeri Widyastuti is Dean of Faculty of Agricultural Technology, Widya Mandala Surabaya Catholic University from 2009 until now. She focuses on Food Chemistry and Human Nutrition researches. Development of functional food and drink based on papaya is her research focus. She has lecturing experience on functional foods for several years. She presented/published her researches in national journals/ international seminars. She is a member of Indonesian Association of Food Technologists. Consulting and training on food and nutrition for food industry practicists and society are also her activities.

Ignatius Srianta is Head of Center for Food and Nutrition Research, Widya Mandala Surabaya Catholic University from 2002 until now. He is a lecturer at Department of Food Technology, Faculty of Agricultural Technology, Widya Mandala Surabaya Catholic University from 2000 until now. He has working experience as a researcher at Technical Development Center of PT Ajinomoto Indonesia in 1999-2000. He is a member of Indonesian Association of Food Technologists. He has experience in a variety of training in the field of food processing and food analysis in Indonesia and United States of America. He presented/published his researches in national/international journals/seminars.

REFERENCES

AOAC (1997) *Official Methods of Analysis of the Association of Official Analytical Chemists*. Arlington, Virginia: AOAC Inc.

Akiokato, Takahashi, A., Matsudoni, N. and Kobayashi, K. (1983) 'Determination of foaming properties of protein by conductivity measurements', *Journal of Food Science*, Vol. 48, pp. 62-65.

Asp, N.G., Johansson, C.G., Hallmer, H. and Siljestrom, M. (1983) 'Rapid enzymatic assay of insoluble and soluble dietary fiber', *Journal of Agricultural and Food Chemistry,* Vol. 31, pp. 476-482.

Beristain, C.I., Cortes, R., Casillas, M.A. and Diaz R. (1991) 'Obtainment of pineapple juice powder by foam-mat drying', *Archivos Latinoamericanos de Nutricion*, Vol. 41, pp. 238-245.

Cheftel, J. C., Cug, D., and Lorient (1985) *Amino Acid, Peptides, and Proteins*, in Food Chemistry: Ed. O.R Fennema. New York: Marcel Dekker, Inc.

Damodaran, S., Parkin, K.L., and Fennema, Q. R. (2008) *Fennema's Food Chemistry 4th edition*. Boca Raton : CRC Press

Durian, D.J. (1995) 'Foam mechanics at the bubble scale', *Physical Review Letters*, Vol. 75, pp. 4780-4783.

Falade, R.O., Adeyanju, K.I. and Uzo-Peters, P.I. (2003) 'Foam-mat drying of cowpea (*Vigna unguiculata*) using glyceryl monostearat and egg albumin as foaming agents', Europe Food Research Technology Vol. 217, pp. 486-491.

FAO (Food and Agriculture Organization) (2010[a]) *FAOSTAT*. Available at http://faostat.fao.org/site/339/default.aspx

FAO (Food and Agriculture Organization) (2010[b]) *FAOSTAT*. Available at http://faostat.fao.org/site/567/DesktopDefault.aspx

Fardiaz, D., Andarwulan, N., Harantono, H.W. and Puspitasari, N.L. (1992) *Laboratory manual: Analytical Technique of Chemical and Functional Properties of Food Components*. Bogor Agricultural University.

Hart, M.R., Graham, R.P., Ginnette, L.F. and Morgan, A.I. (1967) 'Foams for foam-mat drying', *Food Technology*, Vol.17, pp. 1302-1304.

Higgins, P.D.R. and Johanson, J.F. (2004) 'Epidemiology of chronic constipation in North America: a systematic review', *American Journal of Gastroenterology*, Vol. 99, pp. 750-759.

Jossy (1999) *Effect of pH and Arabic gum concentration on physicochemical and organoleptic of instant passion fruit*. Thesis: Widya Mandala Surabaya Catholic University.

Jun, D., Park, H., Lee, O., Lee, H., Yoon, B., Hahm, J., Lee, M., Lee, D. and Kee, C. (2006) 'A population-based study on bowel habits in a Korean community: prevalence of functional constipation and self-reported constipation', *Digestive Disease Science*, Vol. 51, pp. 1471-1477.

Kakino, M., Tazawa, S., Maruyama, H., Tsuruma, K., Araki, Y., Shimazawa, M. and Hara, H. (2010). 'Laxative effects of agarwood on low-fiber diet-induced constipation in rats', *BMC Complementary and Alternative Medicine*, Vol. 10: 68.

Klaschik, E., Nauck, F. and Ostgathe, C. (2003) 'Constipation-modern laxative therapy', *Support Care Cancer*, Vol. 11, pp. 679-685.

Komes, D., Lovric, T., Ganic, K.K., Kljusuric, J.G. and Banovic, M. (2005) 'Trehalose improves flavor retention in dehydrated apricot puree', *International Journal of Food Science and Technology*, Vol. 40, pp. 425-435.

Lembo, A. and Camilleri, M. (2003) 'Chronic constipation', *The New England Journal of Medicine*, Vol. 349, pp. 1360-1368.

Muthukumaran, A. (2007) *Foam-mat freeze drying of egg white and mathematical modelling*. Thesis: Department of Bioresource Engineering MacDonald Campus of McGill University. Available at http://www.agrenv.mcgill.ca/agreng/theses/theses/354ArunMuthukumaran

Lomakina, K. and Mikova, K. (2005) 'A Study of the factors affecting the foaming properties of egg white – a review', *Czech Journal of Food Science*, Vol. 24, pp. 110-118.

Peppas, G., Alexiou, V., Mourtzoulkou, E. and Falagas, M. (2008) 'Epidemiology of constipation in Europe and Oceania: a systematic review', *BMC Gastroenterology*, Vol. 8: 5.

Raharitsifa, N., Genovese, D.B. and Ratti, C. (2006) 'Characterization of apple juice foams for foam-mat drying prepared with egg white protein and methylcellulose', *Journal of Food Science*, Vol. 71, No. 3, pp. E142-E151.

Rajkumar, P. and Kailappan, R. (2006) 'Optimizing the process parameters for foam mat drying of totapuri mango pulp', *Madras Agricultural Journal*, Vol. 93, pp. 86-98.

Rajkumar, P., Kailappan, R., Viswanathan, R., Raghavan, G.S.V. and Ratti, C. (2007) 'Foam mat drying of alphonso mango pulp', *Drying Technology*, Vol. 25, pp. 357-365.

Ramaswamy, H. and Marcotte, M. (2006) *Food Processing Principles and Applications*. Bocca Raton: CRC Press. P 295-296.

Ratti, C. and Kudra, T. (2006) 'Drying of foamed biological materials: opportunities and challenges', *Drying Technology*, Vol. 24, pp. 1101-1108.

Rush, E.C., Patel, M., Plank, L.D. and Ferguson, L.R. (2002) 'Kiwifruit promotes laxation in the elderly', Asia Pacific Journal of Clinical Nutrition, Vol. 11, pp. 164-168.

Sikorski, Z.E. (2002) *Chemical and Functional Properties of Food Components*. 2nd Edition. Florida: CRC Press. p 138-139.

Teixiera da Silva, J.A., Rashid, Z., Nhut, D.T., Sivakumar, D., Gera, A., Souza Jr., M. T. and Tennant, P.F. (2007) 'Papaya (*Carica papaya* L.) biology and biotechnology', *Tree and Forestry Science and Biotechnology,* Vol. 1, pp. 47-73.

Widyastuti, T.E.W., Marsono, Y. and Noor, Z. (2003) *Characterization of papaya flour as laxative agent: intestinal respons of Spaque Dawley rats*. Proceeding of National Seminar of Indonesian Association of Food Technologists. Yogyakarta, Indonesia.

Widyastuti, T.E.W., Widjajaseputra, A.I. and Srianta, I. (2008) *Potency of papaya (Carica papaya L.) as functional drink: studies on varietes and maturity of papaya.* Annual report of Competitive Research Program of Hibah Bersaing Batch XIV, Directorate General of Higher Education, Department of National Education, Republic of Indonesia.

You, J.S., Park, J.Y. and Chang, K.J. (2010) 'A case-control study on the dietary taurine intake, nutrient status and life stress of functional constipation pateints in Korean male college students', *Journal of Biomedical Science*, Vol. 17: S41.