As. J. Food Ag-Ind. 2008, 1(01), 17-23

Asian Journal of Food and Agro-Industry

ISSN 1905-

Available online at www.ajofai.info

Research Article

Pre-concentration of longan juice extract with microfiltration and reverse osmosis

Montatip Yunchalad[1] Rasamee Supasri[1] Sumitra Boonbamrung[1] Karuna Wongkrajank[1] Chidchom Hiraga[1] and Anukul Watanasook[2]

[1] Institute of Food Research and Product Development, Kasetsart University, Bangkok 10900, Thailand.

[2] Department of Food Science and Technology, Faculty of Agro-industry, Kasetsart University, Bangkok 10900, Thailand.

Paper originally presented at Food Innovation Asia 2007

Abstract: Dried longans are widely consumed in Asia as an herbal fruit and this research explores the possibility of developing a healthy value-added longan juice. The experiment was carried out using water extraction mixed with enzyme treatment prior to processing the longan juice pre-concentrate with microfiltration (MF) and reverse osmosis (RO), respectively. It was found that yields of the pre-concentrated longan juice were 71.63 ± 1.31% and 37.69 ± 2.72% obtained from MF and RO process, respectively, under optimal operation parameters. Total yield of pre-concentrated longan juice was only 21.67 ± 0.95% of the dried longan. Following this, pre-concentrated longan juice in a hermetically sealed container (90 ml) was sterilized at 240^{o}F for 20 min providing 4.8 min of sterilizing value (F_o) for product safety. Chemical and microbial qualities and nutrient compositions of the product were then preliminary investigated. Results showed that the product had 25.87 ± 1.63% TSS, pH 5.16 ± 0.09 and 0.42 ± 0.03% acid as anh.citric acid. Furthermore, the microfiltration membrane could still retain protein, sucrose, glucose, fructose, some vitamins and minerals in longan juice pre-concentrate compared to the dried longan.

Keywords: Dried longan, longan juice extract, longan juice pre-concentrate, MF, RO

Introduction

Longan (*Nephelium longana* Cambess or *Euphoria Longana* Lam) is a member of the family Sapindacaeae. Longan is an economic fruit which provides high income for

Thailand in both fresh and processed products such as canned in syrup or dried longan. Dried whole shell longan is separated into three grades according to diameter. Longan grade C is used for making juice. The dried pulp is black, has a smoky flavour and is mainly used to prepare drinks. Longan fruit contains several vitamins and minerals such as iron, magnesium, phosphorus and potassium, and large amounts of vitamins A and C. Longan has long been used as an ancient Chinese medicine which is sweet and helps to keep the body warm, is good for the heart and spleen, abates symptomatic insomnia, improves memory and increases efficiency of blood circulation. Longan has medicinal attributes and mineral salt properties that the body needs such as a slight amount copper, zinc etc. As a result, dried longan is a popular export for countries which have a Chinese population. The major markets for dried longan are Singapore, Hong Kong, China and Korea etc. (Suthatham, 2003).

However, longan juice prepared from dried longan and then concentrated as single - strength juice should be studied due to the rich nutrient composition. Dried longan is the same as prune juice, which differs from other fruit beverages in that it is a water extract of dried fruit, rather than squeezing of fresh produce (Luh, 1980). Popularly membrane technology has been used for processing of fruit juice. Ultrafiltration and microfiltration (MF) can be applied for clarification and reverse osmosis (RO) for concentration or de-watering. Using the membrane process could avoid product degradation problems associated with thermal processes, thus resulting in products with better functional and nutritional properties (Cheryan, 1987). MF usually utilizes membranes with pore sizes of (0.1-10 μm). Only very large macromolecular groups (large fat globules) and suspended particles (e.g. microbial cell) are held back by the membrane, the remainder of the components being retained in the solution (Ferguson, 1989). Using MF with aseptic processing and packaging, a cold sterilized juice could potentially be produced. Grohmann and Feuerpeil (1987) mentioned that mineral membranes (e.g. ceramic) that can be thermally sterilized provide maximum operating safety in the production of a cold sterile juice using tangential flow systems. They were able to produce a cold sterile apple juice with a 0.2 μm ceramic membrane on a large scale. In the cases where RO is used for dewatering purposes, the process needs relatively high pressure (10-50 bar) because its pore size is very small (0.0001-0.001 μm) (Ferguson, 1989). The major constraint with RO is that high concentrations are difficult to obtain because of the high osmotic pressures reached by retentive juice. Membrane processes should be viewed as a first stage process with other technologies like freeze concentration or evaporation completing the concentration system (Girard and Fukumoto, 2000). Even though using membrane technology results in high cost, applying the membrane process for fruit juice should be studied and tested. This research was conducted using pilot plant scale equipment of MF and RO for pre-concentration longan juice as a new product development which would be a healthy drink with high value-addition. The objective of this preliminary study is to process longan juice pre-concentrate from dried longan using the membrane system and investigate nutrients of pre-concentrated longan juice in hermetically sealed containers.

Materials and Methods

Preparation of longan water extract

Dried longan flesh *E-door* cultivar was purchased from the Northern Agricultural Cooperative in Chiang Mai. The dried longan flesh mixed with 7 times the volume of water was disintegrated by Reitz Disintegrater which consisted of fine perforated screen.

Longan pulp was cooked by maintaining moderate temperature for 30 min, treated with a fixed amount of enzyme Celluclast 0.02% and Pectinex Ultra^{TM} SP L 0.01% at 55^{o}C for 1 hr. Liquefied longan pulp was then filtered to separate longan water extract for further treatment with the membrane system.

Clarified longan juice pre-concentrated preparation by MF and RO

Filtrate of liquefied longan pulp was transferred into a pilot cross flow microfiltration system (T.I.A. Bollene, France) consisting of a cartridge fitted with a hexagonal multichannel ceramic tubular membrane, of which there were 19 channels of 6 mm i.d. and 850 mm length with a membrane pore diameter of 0.2 microns, resulting in a total surface membrane of 0.3 m^2. All subsequent filtration was carried out at the same temperature with operating parameters on permeate flux of transmembrane pressure controlled at about 2 bar. Permeate was withdrawn and retentate continuously recirculated back to the feed kettle via a second loop. Permeate flow was measured by a graduated cylinder and a stop watch for every 5 min/min.

The clarified permeate was then pre-concentrated to remove about 50% of water by reverse osmosis system (T.I.A. Bollene, France) consisting of a FILM TEC® RO Element (SW 30 – 2540 type, Minneapolis, USA) with a total surface of a thin film composite polyamide membrane of 2m^2. Water was diffused under high pressure (40 bar) through a membrane. Flow conditions were carefully controlled to minimize the effect of solute built-up at the surface of the membrane. The permeate rate was measured by graduated cylinder with a stop watch at every 5 min/min collection. Retentate was collected in the kettle for further preservation.

Thermal process preservation

The retentate from RO resulted in a clarified longan juice pre-concentrate product. It was pre-heated prior to filling into a bottle of 90 ml capacity and capping. The product was sterilized at 240^{o}F for 20 min, then cooled for further microbial analysis.

Physical and chemical characteristic investigation

Dried longan and sterilized longan juice pre-concentrate products were analyzed as follows: Proximate analysis (AOAC, 1993); mineral (In-house method , ICP); vitamin (In-house method, Micro Assay and HPLC); sugar (In-house method , AOAC 982.14); microbial analysis (FDA–BAM 2001). Sterilizing value was determined by Ellab-Val™ Software ver.1.20.

Results and Discussion

Preparation of longan water extract

Longan juice processing was done by the disintegration method. Optimal water content used was determined from the experimental result that provided highest yield. Luh (1980) mentioned that prune juice processing technology by the disintegration method gave higher yield and superior flavour than the diffusion process. It was found that there are large insoluble and soluble complexes in longan water extract including coarse dispersed

particles and colloids. Therefore, Celluclast enzyme and pectinase mixture was applied in order to achieve a more soluble solid extract and to improve yield. The extract was filtered through muslin cloth because of some residue of longan peel and seed that must be removed to prevent the rotor of pump in MF equipment from damage.

Clarified longan juice pre-concentrated preparation by MF and RO

The longan juice was filtered to remove some residue prior to microfiltration and reverse osmosis steps. Consequently, the filtered longan juice yield was only 88.17 ± 7.79%. Table 1 shows the characteristics and resultant product quality; 71.63 ± 1.31% permeate of MF, 37.69 ± 2.72% retentate of RO, as permeate of MF and retentate of RO have been affected by pressure, temperature, flow rate and concentration during operation. Results showed that the RO process could remove more than 60% of the water content. RO has also been a useful application for maple sap concentration where up to 75% of water can be removed (Underwood and Willits, 1969). In conclusion, the MF and RO processes provided 21.67 ± 0.95% yield of longan juice pre-concentrate from dried longan. After thermal processing, sterilized longan juice pre-concentrate had 25.87 ± 1.63^{O}Brix, 5.16 ± 0.09 pH and 0.42 ± 0.03% acid as anh.citric acid (Table 1). Some sediment was found at the bottom of the bottle, as well as the formation of a burnt flavour and darkening due to the presence of protein and reduced sugar content (Table 3). Belleville *et al*. (1990) found that the reduction of turbidity in wine was relatively small after MF using a porous alumina membrane with 0.2 pore size. However, the product was safe for consumption and shelf stable with respect to the results of sterilizing value (F_o) and the microbiological analysis (Table 2).

Table 1. Some characteristics of longan juice pre-concentrate by MF and RO.

Particular	Product quality
Filtrate of liquefied longan pulp, %	88.17 ± 7.79
Permeate of MF, %	71.63 ± 1.31
^{O}Brix of permeate	9.87 ± 0.91
Concentrate of RO, %	37.69 ± 2.72
^{O} Brix longan juice pre-concentrate	25.87 ± 1.63
Yield: longan juice pre-concentrate from dry longan, %	21.67 ± 0.95

*Triplicate experiments

Table 2. Physicochemical and microbial analysis of sterilized longan juice pre-concentrate in bottle.

Particular	Result
^{O}Brix longan juice pre-concentrate	25.87 ± 1.63
pH of longan juice pr-concentrate	5.16 ± 0.09
%Acid as anh.citric acid of longan juice pre-concentrate	0.42 ± 0.03
Processing time 20 min at 240^{o}F, Sterilizing value(min)	4.8
Incubation test	Normal
Total plate count, cfu/ml	None
Flat sour mesophiles	Negative
Flat sour thermophiles	Negative
Mesophilic anaerobes	Negative
Thermophilic anaerobes	Negative
Sulfide spoilage	Negative

Composition of longan products

Retentive constituents of longan juice extract by MF, followed by water removal by RO revealed almost the same compounds compared to the dried longan (Table 3 and Table 4). Based on size, low MW compounds in fruit juice include mostly sugar, organic acid, amino acid, essential oils, volatiles, vitamins and minerals (Hendrix and Redd, 1990).

Conclusion

Pre-concentrated longan juice in hermetically sealed containers shows good potential to be a new healthy herbal drink. The preliminary identification only showed that most nutrient constituents were still retained as compared to the dried longan. Attributes of phytochemical bioactive compounds in the product should be further studied to produce some more information on the active compound activities in dried longan flesh used in Chinese medicine.

Table 3. Nutrient composition of longan products

Particular	Dried longan	Longan juice pre-concentrate
Moisture , %	13.41	73.58
Protein , (factor 6.25)	3.74	1.64
Fat , %	0.44	0.02
Ash , %	6.44	2.03
Total Carbohydrate , % (by difference ; include dietary fibre)	75.97	22.73
Dietary fibre,%	5.42	0.09
Sucrose , g/100 g	44.20	14.21
Glucose, g/100 g	14.05	2.77
Fructose , g/100 g	17.64	3.91
Vitamin B2 , mg/100 g	0.06	0.08
Vitamin B3 , mg/100 g	4.60	1.58
Vitamin B5 , mg/100 g	0.06	0.05
Vitamin C , mg/100 g	1.58	-
Sodium , mg/kg	5.02	7.77
Phosphorus , mg/100 g	140.00	-
Potassium , mg/100 g	820	-
Calcium,mg/100 g	-	2.09
Iron , mg/kg	11.27	0.15

- not determined

Table 4. Amino acid profile of longan products

Particular	Dried longan	Longan juice pre-concentrate
Alanine , mg/100 ml	294	136
Arginine , mg/100 ml	227	43
Glutamic acid , mg/100 ml	459	242
Glycine , mg/100 ml	445	110
Histidine , mg/100 ml	82	139
Isoleucine , mg/100 ml	153	30
Leucine , mg/100 ml	172	34
Lysine , mg/100 ml	73	34
Methionine , mg/100 ml	94	48
Phenylanine , mg/100 ml	117	14
Cystine , mg/100 ml	74	35
Aspartic acid , mg/100 ml	187	60
Tyrosine , mg/100 ml	107	49
Proline , mg/100 ml	137	27
Serine , mg/100 ml	278	83
Threonine , mg/100 ml	294	136
Tryptophan , mg/100 ml	9	6
Valine , mg/100 ml	205	172

Acknowledgment

The authors would like to thank Kasetsart University Research and Development Institute, for financial support.

References

1. Belleville, M.P., Brillouet J.M., Tarado de la Fuente, B. and Moutounet, M. (1990). Polysaccharide effects on cross-flow microfiltration of two red wines with a micropourous alumina membrane. J. Food Sci. 55:1598.

2. Cheryan, M. (1987). Membrane Technology in Food Processing. In: Trends in Food Processing. I. Ghee, Ang-How, Kuan, L.C., Tan, C., and Chang, S., (eds.). Proceedings of the 7th World Congress of Food Science and Technology; October, 1987; Singapore, 387p.

3. Ferguson, P.H. (1989). Membrane processing in the food and dairy industries. In: Process Engineering in the Food Industry Development and Opportunities. Field, R.W., and Howell, J.A., (eds.). Elsevier Applied Science, London & New York, p.237-238.

4. Girard, B. and Fukumoto, L.R. (2000). Membrane Processing of Fruit Juice and Beverages: A Review. Critical Reviews in Food Science and Nutrition, 40 (2):91-157.

5. Grohmann, M. and Feuerpeil, H.P. (1987). Cold sterile apple juice - cold sterile filtrates with tangential flow filtration. Confructa Studien, 31,171.

6. Petrus Cuperus, F. (1998). Membrane Processes in Agro-Food: State-of-the-Art and New Opportunities. Separation & Purification Technology, 14 (1-3):233-239.

7. Hendrix, C.M. and Redd, J.B. (1990). Chemistry and technology of citrus juices and by products, In: Production and packaging of non carbonated fruit juices and fruit beverages, Chap. 2, Hicks, D. (ed.). Blackie and Son Ltd., London, p33.

8. Luh, B.S. (1980). Nectars pulpy juice and fruit juice blends. In: Fruit and Vegetable Juice Process Technology, Tressler, D.K. and Joslyn, M.A. (eds.). third edition, AVI Publishing Co. Inc., Westport, CT, 678 p.

9. Suthatham, R. (2003). Trade Rules & Regulation. J. National Food Institute. 5 (29): 30-37.

10. Underwood, J.C. and Willits, C.O. (1969). Operation of a reverse osmosis plant for the partial concentration of maple syrup. Food Technol., 23: 79.