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ORIGINAL RESEARCH PAPER

PHYSICOCHEMICAL AND SENSORY CHARACTERISTIC OF SOYA PROTEIN ISOLATE FORTIFIED PAPAYA JAM DURING STORAGE TIME

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Abstract: Protein fortification of fruit product have been a trend in the last decade to solve the lack of protein contain in it. However, the right composition for the fortification have been a problem since long. The research was done to give a sight of formulation and the effect of it in changes of physicochemical and overall acceptability of papaya jam. Fortification was done with formulation 40:1, 40:2, 40:3, 40:4, 40:5 of papaya pulp: soya protein isolate (part/part). Moisture, TSS, *p*H, total and reducing sugar, non-enzymatic browning, ascorbic acid, total carotenoid, crude protein, total plate count and overall acceptability of highest acceptability formula was analyzed at monthly interval during three months storage time. Moisture, TSS, *p*H, total and reducing sugars and non-enzymatic browning increased, while ascorbic acid, total carotenoids, and crude protein contents of jam decreased during storage. Total plate count showed no microbial during storage periods. Soya protein isolate fortified papaya jam remained acceptable during storage although the acceptability was decrease during time.

Keywords: *acceptability, fortification, papaya jam, protein isolate, storage time, physicochemical*

INTRODUCTION

Papaya (*Carica papaya* L.) was commonly found in wide area from sub-tropical to tropical with annual papaya production around 13000000 metric tons. Since 1998, the production of this fruit was led by sub-tropical countries like Mexico, Brazil, India, Nigeria, and Congo [1]. Known as magical fruit, it contents Pro-Vitamin A carotenoids average 232 µg *β*-carotene and 594 µg *β*-cryptoxanthin/100 g and vitamin A ranged from 18 to 74 µg RAE (retinol activity equivalents)/100 g. Lycopene content in the red-fleshed varieties ranged from 1350-3674 µg/100 g [2]. The vitamin C of this fruit is also very high, approximately 50 mg/100 g [3]. Despite of the potential it has, papaya easily deteriorated in post-harvest process. The loss of it reached 40 % [4]. That's why most of papaya producing country has no other option but to develop an alternative for papaya fruit product to reduce the post-harvest loss.

Jam was one of the fruit product gains a good popularity in this decades. Jam means the product prepared from sound, ripe, fresh, dehydrated, frozen or previously packed fruits including fruit juices, fruit pulp, fruit juice concentrate or dry fruit by boiling its pieces or pulp or puree with nutritive sweeteners namely sugar, dextrose, invert sugar or liquid glucose to a suitable consistency [5]. Papaya jam has a high popularity, whether produced as mixed jam or originally served as papaya jam. It was claimed that jams, especially papaya jam, provides good energies with half bout of calories since the present of fibre and fructose will maintain the sugar level and satiety level of the consumers. It also still contains some nutritional value of papaya [6]. However, like any other fruit product, protein contain in it was very low. Fortification protein still needed to increase the nutritional value of papaya jam.

Protein fortification have been a trend in increasing the nutritional value of fruit product. Researches were conducted since improper composition of protein fortification may resulted in change of physicochemical characteristic of fruit product. Final result will be the low acceptability of fruit product. The researches was vary from fortification of whey concentrate protein in banana-cactus pear mixed fruit bar [7], fortification of whey protein in Bael fruit bar [8], protein fortification of ready to serve beverages [9-10], but very less references for protein fortification in jam. The lack of references resulting ineffective fortification procedure like in guava jam [11]. Some researchers found that the fortification not significantly increase the protein content of jams. That's why research about physicochemical characteristic and overall acceptability of fortified papaya jam was very important to conduct. By knowing so, we can create a references and basic model for protein fortified papaya jam development.

MATERIAL AND METHODS

Materials

Ripe Papaya cv. Disco fruits was procured from the local market, Hisar, Haryana, India. The papaya fruits were washed thoroughly with clean running water and cut into slices with stainless steel knife. The slices were grinded in a grinder and Sodium Benzoate was added as preservative by ratio 1g/1kg.

Chemicals

The chemical used for analysis was procured from chemical stock of Centre of Food Science and Technology, Chaudhary Charan Singh Haryana Agricultural University. Chemicals were produced by Atul Ltd. Chemical Company. The soy protein isolate was procured from Titan Biotech Ltd (India).

Jam Production

For each kilogram of papaya pulp, 700 g of sugar, 4 g of citric acid, and 2 g of pectin was added. The mixture was cooked with constant stirring until thick consistency achieved. End point was judged by sheet test and measuring total soluble solids (68 %) using hand refractometer (58 - 92 %). The product was packed in 150 g capacity sterilized glass jars and stored.

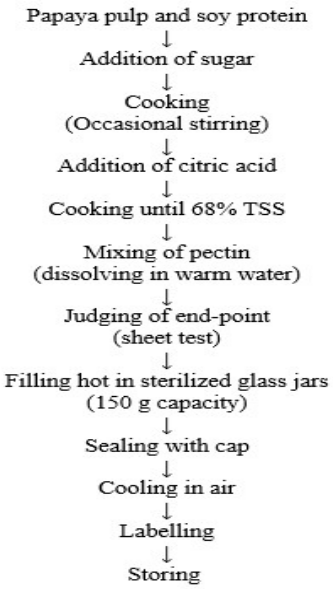

Figure 1. *Flow sheet for preparation of jam*

Formulation for Fortification

Soya isolate were added to papaya pulp in the following combinations:

i) 40 parts papaya pulp : 1 parts soy isolate
ii) 40 parts papaya pulp : 2 parts soy isolate
iii) 40 parts papaya pulp : 3 parts soy isolate
iv) 40 parts papaya pulp : 4 parts soy isolate
v) 40 parts papaya pulp : 5 parts soy isolate
vi) 100 % papaya pulp as control

Gelling characteristic and the result of sensory evaluation for each combination was used to determine which proportion that will be analysed further for changes of physicochemical and acceptability during storage time.

Physicochemical Characteristic Analysis

Total soluble solids (TSS) of jam calculated in °Brix. TSS determination was done using Abbey refractometer (Bausch and Lomb, Switzerland). Samples were placed on the sample holder of the refractometer that had been standardized to the zero mark with distilled water. The refractive index and °Brix were read from refractometer. *p*H was determined using *p*H meter (model BA 350 EDT instruments, UK). Moisture content was analyzed using oven method. Ascorbic Acid Content and Crude Protein was analyzed using AOAC standard method [12]. Total and Reducing Sugar was analyzed using Hulme and Narain method [13], while total carotenoids were determined as per the procedure described by Rodriguez-Amaya [14]. Non – Enzymatic Browning was recorded for fresh product and stored product, by the procedure as described by Ranganna [15]. Microbial analysis was conducted using Total Plate Count (TPC) method using serial dilution technique. Organoleptic evaluation was conducted using 9 (nine) level hedonic scale method described by Ranganna [15]. All the data was collected during 3-month storage time.
In monthly interval, the data collected was analysed statistically using ANOVA method. Complete Randomized Design (CRD) with 5 % level in critical difference value was used as research design.

RESULTS AND DISCUSSION

Standardization

Formulation was done to standardize composition for addition of soya protein isolate. The result was described as shown in Table 1. Justification of the quality from each formulation was done using CODEX STAN 296 [16]. CODEX STAN 296 described that a good jam should at least having a soft even consistency without distinct pieces of fruit, a bright color, a good fruit flavor, semi-jellied texture without free liquid and easy to spread. The result fulfills this standard that will only be analyzed further.
Based on the standard it was found that only control (100 % papaya pulp) and treatment with combination of 40 : 1 and 40 : 2 papaya pulp: soya protein isolate found fulfill the requirement of good jam. The combinations gave appropriate gelled consistency, having normal colour and flavour. It also has glossy, tender texture, soft gel, a little sticky, and a little loose character (Table 1).

Table 1. *Setting characteristics of jam prepared from different combinations of papaya pulp and soya bean concentrate*

Treatments		**Descriptive attributes of jam**		
Combinations	**Ratio**	**Appearance**	**Texture**	**Setting**
Control [papaya]	100	Glossy, tender	Soft, gel	A little loose
Papaya : soy isolate	40:1	Glossy, tender	Soft, gel	A little loose
	40:2	Glossy, tender	Soft, gel	A little loose
	40:3	Glossy, a little pasty	Soft, gel, a little sticky	A little loose
	40:4	Glossy, a little pasty	Soft, gel, a little sticky	A little loose
	40:5	Dull, tender	Hard, gel	Loose

CODEX STAN 296 described that texture of jam should be at least soft and spreadable like gel. For this purpose, the standard set the limit of fruit to 45 % for common fruit so that it doesn't leave grittiness texture in mouth. However, texture was affected by lot off factors. One of it is the additive that being added, fortification material is included.
Protein was not easily soluble in acid condition. Only protein contained negative charge amino acid can be dissolved properly in acid condition. That's why adding protein as fortification object have been a problem since long [17]. Without a proper formulation, as the data shown in Table 1, not all of the combination resulting a desirable result.
The fortified papaya jam that fulfill the standard set by CODEX STAN 296 was subjected to sensory evaluation. The product having highest acceptability was subjected to next data analysis. The result of sensory evaluation was described in Table 2.

Table 2. *Sensory score (9-point hedonic scale) of jam prepared from different combinations of papaya pulp and soy isolate*

Treatments		Color and appearance	Aroma	Taste	Overall acceptability
Combinations	**Ratio**				
Papaya : soy	40:1	8.0	7.8	8.2	8.0
	40:2	8.3	8.0	8.0	8.1

CODEX STAN 296 required that final product of jam shall be of an appropriate gelled consistency, having normal color and flavor appropriate to the type or kind of fruit ingredient used in the preparation of the mixture. So the characteristic that being used for the sensory evaluation was color, and as representative of flavor, aroma and taste was also subjected as parameter. From the sensory evaluation, it was found that combination 40:2 having highest overall acceptability. Despite of having higher level of protein, unlike concentrate, soya protein isolate was having better emulsifying properties [18], functional properties [19], and low in fiber, so that it can be used for fortification in fruit product in much better way [20].
The product with above combination was exposed to physicochemical analysis during 3-month storage time. The result was shown in Table 3 to Table 6.

Table 3. *Changes in physicochemical characteristic that affect consistency*

Storage time	Moisture [%]		TSS [%]		Total sugar [%]		Reducing sugar [%]	
	Fortified product	Control	Fortified product	Control	Fortified product	Control	Fortified product	Control
0 month	31.07	31.51	68	68	53.6	54.1	33.6	32.5
1st month	30.62	31.18	68.5	68.2	54.0	54.4	33.8	32.7
2nd month	30.21	30.93	68.8	68.6	54.8	55	34.3	33.2
3th month	30.02	30.57	69	69	55.1	55.5	34.8	33.6
Mean	**30.49**	**31.05**	**68.6**	**68.5**	**54.2**	**54.5**	**34.1**	**33**
CD at 5 %	**NS**		**NS**		**NS**		**NS**	

Moisture increased 1.83 % during storage time. Moisture affects consistency of jam by mean of providing thickness characteristic to it. If jam having less moisture, it will have a hard and thick characteristic, which lead to decrease of acceptability. If the moisture was too high, it will lead to loose texture so that it will have very less spreadability, and

will lead to higher risk of microbial contamination [21]. Addition of protein may retain the water solubility in food material [22] so that in result the moisture contain of fortified product was lesser compared to control (Table 3). However, the difference was not significant. Decrease of moisture during storage time might be due to evaporation of water. Moisture content of bot fortified jam and control are still in range of standard for a good jam (30 - 41 % of moisture content) [23].

Gelling characteristic and consistency of jam was determined by pectin content in it. Pectin will not give gel characteristic when it has less than 50 % sugar as it cosolute [24]. Addition of sugar may help jams in reaching it consistency. Although fortified jams shown lesser amount of total sugar, the difference found to be non-significant compared to control (Table. 3). Both fortified jam and control still having total sugar in range for resulting a good gel consistency in jam (more than 50 %). Total sugar of jam increased during storage time in accordance with the decrease of moisture. The lower the moisture of fruit product, the more concentration of the component of that product, thus is resulting in increase of total sugar. Same pattern was found in other previous researches in jam [25 – 28].

Total Soluble Solid (TSS) was the main component affecting viscosity, thus contribute more in consistency of jam. TSS represents all soluble components in a material. The higher the TSS the higher the viscosity is resulting in hardness characteristic of food product [29]. The difference of treatment and control was non-significant during 3-month storage period (Table 3). From the result, we can conclude that fortification was not affecting TSS. During storage period, the TSS was increase both in treatment and control. The increase may due to the precipitation of water during storage. The result was in accordance with previous researches [25 – 28].

In term of consistency, reducing sugar was the indicator of pectinolytic activity. From reaction resulting pectinase complex that play a major role in consistency and structure of jam [30]. Adding protein in jams might result in increase of reducing sugar. The result was showing that fortified product having higher reducing sugar compared to control (Table 3). However, the difference was not significant. During storage time, reducing sugar was increasing. The increase in reducing sugar content during storage was mainly due to the inversion of non-reducing sugar into reducing sugars [31]. The previous researches also showed same pattern [25 – 28].

Table 4. *Changes in physicochemical characteristic that affect astringency*

Storage time	*p*H		Ascorbic Acid (mg/100g)	
	Fortified product	**Control**	**Fortified Product**	**Control**
0 month	3.03	3.27	31.3	39.3
1st month	3.13	3.41	28.3	31.1
2nd month	3.34	3.55	22.8	27.9
3th month	3.48	3.76	19.6	24.2
Mean	**3.24**	**3.5**	**25.5**	**30.6**
CD at 5 %	**NS**		**NS**	

Astringency was characteristic determined by acidity of fruit product. The indicator of it is *p*H. The higher *p*H of a fruit product is, the stronger its astringency. In this research, fortification found to affect the *p*H (Table. 4). However, the change of it was not significant. During storage, *p*H of both fortified product and control was increasing. The

increase in *p*H of soy protein fortified jams could be the result of conversion of proteins to amino acids. Previous research on jam showed that *p*H of jams tends to increase during storage [32 – 35].
Main factor affecting *p*H was the ascorbic acid content on it. Ascorbic acid of fortified product found lesser compared to control (Table 4). This could be the result of oxidation of ascorbic acid to reduce Maillard reaction in jam. The more protein content in food, the higher possibility for Maillard reaction is. Ascorbic acid was component found effective in reducing Maillard reaction [36]. Both fortified product and control's ascorbic acid content was decreasing during storage period. Although ascorbic acid content of fortified product was lesser compared to control each month, the difference found be not significant. From this we can conclude that fortification affecting astringency, but the difference found to be not significant.

Table 5. *Changes in physicochemical characteristic in term of nutrition factor*

Storage time	Total Carotenoid (mg/100g)		Crude protein (% dwb)*	
	Fortified product	Control	Fortified product	Control
0 month	2.81	2.98	6.43	3.26
1st month	2.79	2.88	6.31	3.19
2nd month	2.53	2.8	6.22	3.1
3th month	2.40	2.72	6.13	3.05
Mean	**2.63**	**2.85**	**6.27**	**3.15**
CD at 5%	**NS**		**0.12**	

Total carotenoid of control was slightly higher compared to fortified jam (Table 5). During storage time, total carotenoid of both control and treatment was decrease during storage time. Total carotenoid represent some nutrient value of jams since it act as antioxidant and precursor of vitamin A [37]. Degradation of carotenoids may have occurred through isomerization of *trans* pro-vitamin A to the *cis*-isomers which on further oxidation leads to the formation of low molecular mass compounds [38]. However, the difference and changes of total carotenoid between control and fortified product during storage time found to be not significant.
With the formulation used in this research, it was found that the treatment could almost double the crude protein content of papaya jam (Table 5). Formulation was the main key of protein fortification in fruit product. With improper formulation, protein fortification may result in unacceptable fruit product or low impact of protein fortification. Some may lead to insignificant increase of crude protein content in it [11]. Although the amount of crude protein in both fortified papaya jam and control was decreasing during storage time, this research show that fortification of soya protein isolate with ratio (40 : 2) having a very good impact in protein factor of papaya jam.
Non-enzymatic browning affects the final acceptability by changing the color of final product. In fruit product it may reduce the acceptance of product by giving brownish color to it so that the freshness image of product reduced. Adding protein to papaya jam means adding more amino acid into it. That's why in fortified product, non-enzymatic browning observed higher compared to control [39]. During storage time, non-enzymatic browning of both treatment and control was increase (Table 6).

Table 6. *Overall acceptability, total plate count, and non-enzymatic browning*

Storage time	Overall acceptability		Total plate count (log cfu·g^{-1})		Non-enzymatic Browning (OD at 440 nm)	
	Fortified product	Control	Fortified product	Control	Fortified product	Control
0 month	8.5	8.6	-	-	0.076	0.07
1st month	8.2	8.4	-	-	0.098	0.079
2nd month	7.9	8.3	-	-	0.106	0.098
3th month	7.8	8	-	-	0.118	0.102
Mean	8	8.3	-	-	**0.1**	**0.086**
CD at 5 %	**NS**		**Not detected**		**NS**	

Although non-enzymatic browning occurred in fortified product was higher, the difference found to be not significant. The result was in accordance with other researches in fruit product [40 – 41]. From this result we can conclude that the fortification using formula in this research affecting the coloration but it was found that the effect was not significant.

Using total plate count method, it was found that there was no microbial growth observed (Table 6). Jam having high sugar content thus restricted the growth of microbes especially bacteria. CODEX STAN 296 set requirement for jam that must be free from microbial contaminant for at least 6 months. Using the fortification formulation in this research, it was concluded that the final product fulfils the requirement of good jam in term of microbial growth.

Using sensory evaluation method, overall acceptability of both treatment and control found decreasing during storage period. Fortified papaya jam having lesser acceptability compared to control (Table 6). However statistical analysis found that the difference was not significance. With formulated fortification of soya protein isolate used in this research, it was proved that the final output still having acceptability not much different compared to conventional papaya jam (control).

CONCLUSION

Formulation found to have highest acceptability for fortification using soya protein isolate in papaya jam was 40 pulp : 2 soya protein isolate (part : part). Using formulation above it was found that the physicochemical and overall acceptability of fortified papaya jam during storage time was not different significantly compared to conventional papaya jam (control). In other hand, the crude protein content of fortified papaya jam increase significantly compared to control. During storage, moisture, TSS, *p*H, total and reducing sugars and non-enzymatic browning increased, while ascorbic acid, total carotenoids, and crude protein contents of jam decreased. Total plate count showed no microbial during storage periods. Soya protein isolate fortified papaya jam remained acceptable during storage although the acceptability was decrease during time. Characteristic wise, the formulation used in this research resulting very good quality papaya jam with significant increase of crude protein content.

REFERENCES

1. Kitinoja, L., Kader, A.: *Small-scale postharvest handling practices: a manual for horticultural crops*, University of California, Davis, Postharvest Technology Research and Information Center, **2002**;
2. Luximon Ramma, A., Bahorun, T., Crozier, A.: Antioxidant actions and phenolic and vitamin C contents of common Mauritian exotic fruits, *Journal of the Science of Food and Agriculture*, **2003**, **83** (5), 496-502;
3. Boshra, V., Tajul, A.Y.: Papaya-an innovative raw material for food and pharmaceutical processing industry, *Health & Environtment Journal*, **2013**, **4** (1), 68-75;
4. Oksuz, T., Surek, E., Tacer-Caba, Z., Nilufer-Erdil, D.: Phenolic contents and antioxidant activities of persimmon and red beet jams produced by sucrose impregnation, *Food Science and Technology*, **2015**, **3** (1), 1-8;
5. FSSAI: *Food Safety and Standard Regulations*, *Food Safety and Standard Authority of India*, New Delhi, India, **2010**, 321-327;
6. Gupta, E., Purwar, S., Jaiswal, P., Chaturvedi, R., Rai, G.K.: Sensory evaluation and nutritional composition of developed papaya-gooseberry jam, *Food and Nutrition Sciences*, **2016**, **7** (7), 600-608;
7. Patel, M., Kulkarni, A.S.: Studies on development of protein fortified banana-cactus pear mixed fruit bar, *Chemical Science Review and Letters*, **2017**, **6** (23), 1803-1809;
8. Paramita, E, Arora, E.P.: Studies on development of whey protein fortified fruit bar from bael (*Aegle marmelos)*, *International Journal of Engineering Studies and Technical Approach*, **2015**, **1** (3), 1-8;
9. Sharma, S.K., Zhang, Q.H., Chism, G.W.: Development of a protein fortified fruit beverage and its quality when processed with pulsed electric field treatment, *Journal of food quality*, **1998**, **21**(6), 459-473;
10. Yadav, D.N., Vishwakarma, R.K., Borad, S., Bansal, S., Jaiswal, A.K., Sharma, M.: Development of protein fortified mango based ready-to-serve beverage, *Journal of food science and technology*, **2016**, **53** (10), 3844-3852;
11. Phong, N.V.: Studies on the use of soybean and anola to improve the nutritional quality of guava (*Psidium gujava* L.) jam, *Master Thesis*, Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar, India, **2004**;
12. AOAC: *Official Methods of Analysis* (21st Edition). *Association of Official Analytical Chemists*, Virginia, U.S.A., **2019**;
13. Hulme, A.C., Narain, R.: The ferricyanide method for determination of reducing sugars. A modification of Hagedom-Jensen-Hanes technique, *Biochemical Journal*, **1931**, **25**, 1051-1061;
14. Rodriguez-Amaya, D.B.: A guide to carotenoids analysis in foods, *ILSI Press*, Washington DC, **1999**;
15. Ranganna, S.: Handbook of analysis and quality control for fruit and vegetable products (2nd Ed.), *Tata McGraw-Hill Publishing Co. Ltd.*, New Delhi, India, **2003**;
16. Codex: Codex general standard for jams, jellies, and marmalades, *CODEX STAN 296*, **2015**, 1-3;
17. Kramer, R.M., Shende, V.R., Motl, N., Pace, C.N., Scholtz, J.M.: Toward a molecular understanding of protein solubility: increased negative surface charge correlates with increased solubility, *Biophysical Journal*, **2012**, **102** (8), 1907-15;
18. Tsumura, K., Kugimiya W., Hoshino K.: US patent 6,022,702, **2000**;
19. Mao, X., Hua, Y.: Composition, structure and functional properties of protein concentrates and isolates, *International Journal of Molecular Sciences*, **2012**, **13** (2), 1561-81;
20. Nishinari, K., Fang, Y., Guo, S., Phillips, G.O.: Properties and applications of soy proteins, *In Gums and Stabilisers for the Food Industry*, **2014**, **17**, 28-45;
21. Baker, R.A., Berry, N., Hui, Y.H., Barrett, D.M.: Fruit preserves and jams in processing fruits, *CRC Press*, **2004**;
22. da Silva Teba, C., da Silva, E.M.M., Chávez, D.W., de Carvalho, C.W., Ascheri, J.L.: Effects of whey protein concentrate, feed moisture and temperature on the physicochemical characteristics of a rice-based extruded flour, *Food chemistry*, **2017**, **228**, 287-96;

23. Siddiqui, N.H., Azhar I., Tarar O.M., Masood S., Mahmood Z.A.: Influence of pectin concentrations on physico-chemical and sensory qualities of jams, *World Journal of Pharmacy and Pharmaceutical Sciences*, **2015**, **4** (6), 68-77;
24. Yang, X., Nisar, T., Liang, D., Hou, Y., Sun, L., Guo, Y.: Low methoxyl pectin gelation under alkaline conditions and its rheological properties: Using NaOH as a pH regulator, *Food Hydrocolloids*, **2018**, **79**, 560-571;
25. Nour, A.A.M., Khalid, K.S.M., Osman, G.A.M.: Suitability of some Sudanese mango varieties for jam making, *American Journal of Scientific and Industrial Research*, **2011**, **2** (1), 17-23;
26. Safdar, M. N., Mumtaz A., Hameed,T., Siddiqui N., Khalil S., Amjad M.: Storage studies of jam prepared from different mango varieties, *Pakistan Journal of Nutrition*, **2012**, **11** (7), 555-561;
27. Jakhar, M S., Vaish, P.K., Pathak, S.: Studies on the standardization and preservation of guava (*Psidium guajava* L.) and barbados cherry (*Malpighia glabra* L.) blended ready-to-serve beverage, *Progressive Horticulture*, **2013**, **45** (1), 95-99;
28. Wani, R.A., Prasad V.M., Hakeem, S.A., Sheema, S., Angchuk, S., Dixit, A.: Shelf life of karonda jams (*Carissa carandas* L.) under ambient temperature, *African Journal of Agricultural Research*, **2013**, **8** (21), 2447-2449;
29. Carvalho, G.B., Silva D.P., Santos, J.C., Izário Filho H.J., Vicente A.A., Teixeira,J.A., Maria das Graças, A.F., e Silva, J.B.A.: Total soluble solids from banana: evaluation and optimization of extraction parameters, *Applied biochemistry and biotechnology*, **2009**, **153** (1-3), 34-43;
30. Biz, A., Farias F.C., Motter F.A., de Paula D.H., Richard P., Krieger N., Mitchell D.A.: Pectinase activity determination: an early deceleration in the release of reducing sugars throws a spanner in the works!, *PloS One*, **2014**, **9** (10),109529;
31. Giannakourou, M.C., Dermesonlouoglou, E.K., Taoukis, P.S.: Osmodehydrofreezing: An integrated process for food preservation during frozen storage, *Foods*, **2020**, **9** (8), 1-25;
32. Ashaye, O.A., Adeleke T.O.: Quality attributes of stored Rosella jam, *International Food Research Journal*, **2009**, **16**, 363-371;
33. Bafna, P.G., Manimehalai, N.: Process development of jam utilizing under exploited fruit kokum (*Garcinia indica*), *The Journal of Food Technology Photon*, **2013**, **105**, 146-152;
34. Basu, S., Shivhare U.S., Singh T.V.: Effect of substitution of stevioside and sucralose on rheological, spectral, color and microstructural characteristics of mango jam, *Journal of Food Engineering*, **2013**, **114** (4), 465-76;
35. Souad, A., Jamal, P., Olorunnisola, K.: Effective jam preparations from watermelon waste, *International Food Research Journal*, **2012**, **19** (4), 1545-1549;
36. Yu, A.N., Li, Y., Yang, Y.,Yu, K.: The browning kinetics of the non-enzymatic browning reaction in L-ascorbic acid/basic amino acid systems, *Food Science and Technology*, **2018**, **38** (3), 537-542;
37. Handelman, G.J.: The evolving role of carotenoids in human biochemistry, *Nutrition*, **2001**, **17** (10), 818-822;
38. Chaterjee, G., De Neve J., Dutta A., Das S.: Formulation and statistical evaluation of a ready-to-drink whey based orange beverage and its storage stability, *Revista Mexicana de Ingeniería Quím*, **2015**, **14** (2), 253-264;
39. Kuchi, V.S., Gupta, R., Gupta, R., Tamang, S.: Standardization of recipe for preparation of guava jelly bar, *Journal of crop and weed*, **2014**, **10** (2), 77-81;
40. Chan, Jr, H.T.: Frozen guava and papaya products, in: *Handbook of frozen foods*, (Editors: Hui,Y.H., Legarretta,I.G., Lim, M.H., Murrell, K.D. Wai-Kit Nip), Ed. Marcel Dekker, New York, **2004**, 468-476;
41. Verma, G., Chopra, C.S.: Preparation and preservation of aonla-mango mixed fruit slab, *Beverage and Food World*, **2010**, **37** (1), 60-61.