Evaluation of Physico-Chemical and Nutritional Properties and Microbial Analysis of Some Local Jam and Jelly in Bangladesh

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Received on 13 June 2021, Accepted for publication on 12 October 2021

ABSTRACT

In this study, the nutritional and physico-chemical characteristics of ten popular jam and jelly available in local markets of Bangladesh were evaluated. It was found that the moisture contents of the samples were from 21.07-17.83%. The pH range was 2.5-3.4 indicating the acidic nature of jam and jelly samples. The total solid contents of the samples were from 63 to 68% which were very close to BSTI standard value. The total sugar was between 46.10% to 61.0% and the reducing sugar was between 28.27% to 50.3%. It was found that samples contained very less amount of protein, fat and minerals but the carbohydrate content was very high. No heavy metal or microorganism contamination was found but preservatives in some of the samples were found a little higher than standard value.

Keywords: Jam, Jelly, Bangladesh, Physico-chemical analysis.

1. Introduction

The demand for processed food has increased over last couple of decades. Jam and jelly are popular breakfast supplementary not only in foreign countries, but also in Bangladesh. The fast life people are in the need of readily served products and the meals should now be ready to prepare within limited time span. Jam and jelly are processed food made normally from fruits. Processing of fruits has some advantages [1]. Fruits and vegetables are perishable items which has shorter storage life. If the seasonal fruits are processed into jam, jelly, juices or canned fruits, they can be turned into valuable products and also the withholding capacity of these can be increased. This process increases the life of perishable products and creates a new mean to increase their market value relative to their raw form. It is also advantageous as the surplus can be withdrawn from the market and can be utilized alternately than being dumped as waste [1].

The processing of fruits into different food products such as juices, jams, jellies, marmalades, pickles and fruit syrup etc. brings about different consumer products. Jelly contains 45 weight percent fruit juice and 65 weight percent sugar. These are concentrated to 65 weight percent soluble solids. Fruits contain pectin which act as gelling agent. In some cases pectin, acids, preservatives, coloring and flavouring agents are added during processing of jelly. Jam, on the other hand is similar to jelly except pulp or crushed fruit is used instead of juices. There can be up to 68 weight percent solids in jam [2-3]. These items are very popular as breakfast items all over the world. Jam, jelly, and fruit syrup are also used while making desserts [3].

While the processing of fruits has many advantages, it is also important that these are safe for consumers. Food safety is concerned for mainly chemical, physical and/or microbiological type of hazards [4]. Most of these hazards have both short- and long-term health problems for its consumers. There can be different contaminants present in these food items starting from pesticides or other chemicals applied during the production or contaminants such as heavy metals or dioxins that might occur during processing [5].

Over the years, food safety has been a major problem for Bangladesh. For this, the constitution of Bangladesh gives a lot of attention to food safety. Article 15 of the Bangladesh Constitution (GB, 1972) gives much emphasis on food safety [6].According to the Bangladesh Standards and Testing Institution Ordinance (1985),the government has established the Bangladesh Standards and Testing Institution (BSTI) with the purpose for standardisation, testing, quality control, grading and marking of food and food products. One import task of this organisation is to certify the quality of commodities for local consumption or for export and import [6]. Thus the fruits jam and jelly available in markets are tested and cleared by BSTI.

Previously there has been study about quality assessment of pineapple and mango jelly of Bangladesh [7]. In this study, along with physico-chemical analysis, a consumer's survey was performed to find out the sensory properties two types commercial jelly. It was found that the jelly samples contained sweetener and preservatives [7]. Haque et al. studied the physico-chemical properties of eight different fruits of Bangladesh and the results depicted those native fruits were full of nutrients [8]. There have been studies about jam and jelly in other countries also, for eg. Jeju mandarin orange jelly [9], pineapple and hibiscus jam [10], strawberry jam and jelly [11], guava jelly [12] etc.

In this study, we made an effort to find out the physico-chemical characteristics as well as the nutrient factors and

microbiological contamination of 10 jam and jelly samples taken from the market which are manufactured locally and compared the parameters with those assessed by Bangladesh Standard and Testing Institution (BSTI). Also we experimented if any adulterants were present in these products.

2. Materials and Methods

Materials

Twelve different jam and jelly of the popular brands Ahmed, Pran, BD Food and Shezan were bought from local markets of Dhaka and preserved in freezer during the experimentation. The samples consisted of apple, mango, guava, orange, pineapple and mixed fruit jam and jelly. For the analysis the parameters, the jam and jelly samples were coded with A-H. Specification was done as, A, B, C, D = Orange jelly of four different commercial brands, E= Guava jelly of commercial brand, F= Apple jelly of commercial brand, G= Pineapple jelly of commercial brand, H= Mixed fruit jelly of commercial brand and I, J= Mango jam of two different commercial brands.

3. Analysis of Samples

The moisture content of the samples were determined by using a digital moisture analyzer (Model no. XY-105MV, Hunan, China). For determination of amount of total soluble solids (TSS), the samples were tested in a refractometer (Model no. 9099, ATAGO, Japan) and value of TSS were obtained from the refractometer directly [7]. The pH was measured by using pH meter (Hanna Instruments-ORP) at room temperature and titratable acidity was determined by acid-base method [13].For determination of ash content, the samples were heated in an oven at 600^0C for 6 hrs [8]. After a constant weight was reached, the ash content was determined [13-14].

The amount of total sugar, reducing and non-reducing sugar were determined by Lane and Eynon method [15]. The amount of other soluble solids (artificial sweeteners, salt etc) was estimated using the following equation [7]:

Artificial Sweeteners, Salt = Total Soluble Solid (%) – Total Sugar (%)

The standard AOAC (Association of Official Analytical Chemists-1980) method was followed to find out the crude fiber content of the samples [16]. The total protein content was determined following the Kjeldahl method and the standard AOAC method (AOAC, 1990) was followed to find out the total fat content of the samples [17].

The amount of total carbohydrate was estimated according to the following equation [7]:

Carbohydrate (%) = 100- {Moisture (%) + Protein (%) + Fat (%) + Ash (%)}

The gross food energy was determined according to the following equation [18-19]:

FE = (% CHO x 4) + (% CF x 9) + (% CP x 4)

Where FE = Food Energy in Kcal /g, CF = Crude Fat, CP = Crude Protein.

Vitamin C was determined by titration method using 2, 6-dichliorophenolindophenol [20-21] and AOAC method 963.19 (2000) was used for the determination of sodium benzoate [22].

Flame photometric method was used to determine sodium and potassium contents using a Jenway PFP7 flame photometer and iron content was measured using Thermo-scientific Ice 3000 series atomic absorption spectrometer [8]. Analytical test kit was used to find out arsenic content. Yeast and mould count of the samples were done by following previously described method (APHA, 1967) [23].

4. Results and Discussion

The nutritional and physico-chemical parameters of ten local samples of jam and jelly are given in the Table 1.

Moisture content

The moisture content of ten different fruits jam and jelly samples ranged between 18.5% and 21.2%. Highest and lowest amount of moisture were found in orange jelly samples and other samples had the moisture contents in between. If the moisture content of a sample is high, it affects the flavor of product [24]. Products which have high moisture content usually has low shelf-life [25].

Active acidity and pH

The pH of the jam and jelly samples varied from 2.5 to 3.4. The lowest pH (2.5) was found in orange jelly and the highest was in pineapple jelly (3.4). The standard value for jelly according to literature is 3.4 [7]. Generally, bacteria grow at about neutral pH. The pH values of 2.5–3.8 inhibits most bacteria while the yeasts are unaffected by the low value of pH [7]. The highest value for active acidity was found in orange jelly (Sample B, 0.53%) and lowest amount was found in mango jam (Sample I, 0.19%).The value indicates presence of citric acid which is a good preservative. The reference value given by BSTI for active acidity is $\leq 0.90\%$. Thus the samples had lower value for active acidity than the reference value.

Total soluble solids (TSS)

Sugars and fruit acids are main contributors of total soluble solids (TSS) contents. Generally, the higher TSS value indicates there is more sugar in the sample. In our study, TSS amount of was found highest in pineapple jelly, 68% and lowest in mango jam, 63%.If pectins, metal salts (sodium, potassium, calcium etc.) are present, it will also have a small effect on the TSS value. According to Desrosier and Desrosier, the standard TSS range should be slightly above 65%[26].

Table 1: Physico-chemical and nutritional parameters of popular jam and jelly of Bangladesh.

Analytical Parameters	Samples									
	A	B	C	D	E	F	G	H	I	J
Moisture (%)	18.5	21.2	19.0	17.9	19.6	21.0	20.1	20.4	19.8	19.0
pH	2.6	2.6	2.8	2.5	3.1	2.8	3.4	3.1	2.5	2.7
Titratable acidity (%)	0.45	0.53	0.33	0.50	0.49	0.43	0.44	0.21	0.19	0.49
Total soluble solid (%)	65.82	65.19	67.90	64.38	65.21	66.32	65.19	68.44	67.22	63.80
Ash content (%)	0.055	0.080	0.015	0.011	0.049	0.018	0.025	0.025	0.020	0.042
Vitamin C content (mg/100g)	55.0	58.0	42.0	47.0	51.0	18.0	40.0	16.0	15.0	21.0
Protein content (%)	0.06	0.07	0.03	0.05	0.06	0.01	0.03	0.02	0.04	0.09
Fat content (%)	0.010	0.013	0.023	0.009	0.031	0.011	0.012	0.010	0.021	0.014
Fiber content (%)	0.10	0.18	0.07	0.10	0.10	0.08	0.12	0.17	0.10	0.19
Total carbohydrate (%)	81.2	78.5	81.8	82.0	80.2	78.9	79.5	79.1	80.0	80.5
Energy content (kcal/100g)	325	314	327	328	321	316	318	317	320	323
Iron (ppm)	9.0	5.1	-	9.0	-	6.8	5.9	-	-	-
Copper (ppm)	-	0.75	-	0.30	0.61	0.55	0.60	0.50	-	-
Sodium (ppm)	720	580	600	550	520	700	550	450	450	700
Total plate count per gm	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu
Total Yeast count per gm	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu	<10 cfu

Ash

Ash content indicates the total minerals and heavy metals present in a sample. The highest and lowest as content in this study was found in orange jelly samples of different brands. Sample B had highest ash content of 0.08% whereas sample D had lowest ash content of 0.011%. The ash content varies due to the differences in fruit pulp contents. Ash content in different brands may also vary as artificial sweeteners, salt, preservatives etc. might be present in different amounts in the samples. No trace of heavy metals (as As, Pb, Cu, Zn or Sn) was found in the selected samples.

Protein, Fat, Fibre, Carbohydrate and Energy contents

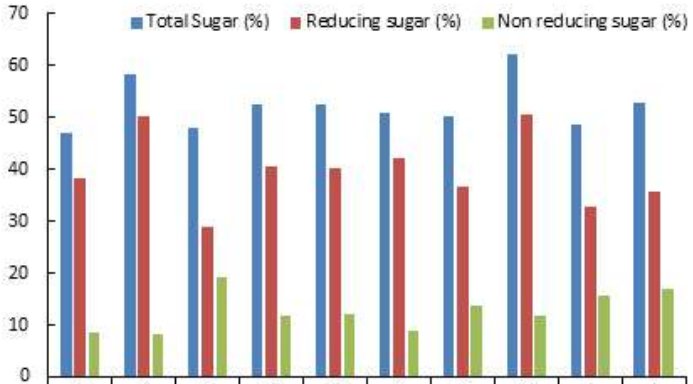
Jam and jelly contain small amount of protein, fat and fibres. According to Norman (1976) protein and fat content of different fruits should not exceed 3.5% and 1%, respectively [27]. In this study, the fat contents were between 0.009-0.023% and the highest and lowest values were in different orange jelly samples. The protein content of different jam and jelly samples ranged between 0.01% in apple jelly and 0.09% mango jam. Fruits which contain high amount of carbohydrate provides higher energy [8]. Sample D showed the highest amount of energy, 328 kcal/100g due to its high carbohydrate content. Sample B had the lowest energy content, 314kcal/100g. The orange jelly (Sample D) had the highest amount of carbohydrate content of 82.0% while another sample of orange jelly (Sample B) had lowest carbohydrate value of 78.5. The fibre content of the samples ranged from 0.07% to 0.19%.

Vitamin C content

In this study, it was observed that orange jelly (Sample B-58.0mg/100g)contained highest amount of vitamin C. The lowest amount of vitamin C was found in mango jam, 15.0 mg/100 g (Sample I). Vitamin C or ascorbic acid fights against bacterial and viral infections and the daily requirement of vitamin C for adult is 40 mg [28]. Thus fruit jam and jelly provides a good source of vitamin C for human body.

Total Sugar, reducing and non-reducing Sugar and artificial sweeteners

From Fig. 1, we can see that highest amount of reducing sugar was found in sample B and H (50%), while lowest amount was found in sample C (28%). This difference may



	A	B	C	D	E	F	G	H	I	J
Total Sugar (%)	46.9	58.29	48.11	52.37	52.48	50.8	50.26	62.29	48.56	52.74
Reducing sugar (%)	38.26	50.11	28.9	40.57	40.34	42.08	36.52	50.47	32.92	35.85
Non reducing sugar (%)	8.64	8.18	19.21	11.8	12.14	8.72	13.74	11.82	15.64	16.89

Fig. 1. Amount of reducing, non-reducing and total sugar in jam and jelly samples.

Table 2: Estimation of other soluble solids (sweeteners, salts etc.) of the test samples.

Samples	Total soluble solid (%)	Total Sugar (%)	Other soluble solids (%)
A	65.82	46.9	18.92
B	65.19	58.29	6.9
C	67.90	48.11	17.79
D	64.38	52.37	12.01
E	65.21	52.48	12.73
F	66.32	50.8	15.52
G	65.19	50.26	14.93
H	68.44	62.29	6.15
I	67.22	48.56	18.66
J	63.80	52.74	11.06

be because of different processing techniques. Sweeteners give texture to jam and jelly and so different type of sweeteners are used during their processing. According to a previous study, an increasing trend with length of storage was found for reducing sugars due to acidic nature of the samples [29]. Anjum *et al.* reported an increase in reducing sugars for apricot diet jam [29]. Previous studies have put a lot of importance on the balance between sucrose and invert sugar ratio of jam and jelly [29-30]. The amount of invert sugar has to be limited and sucrose amount should be higher than invert sugar. According to a previous study, the range of reducing sugar content should be within 20-40% for prevention of crystal separation during storage [230. Recently glucose syrups are used in jams and jellies and it helps to reduce formation of crystals considerably [7]. Among the ten samples, sample J had 16.89% and sample B had 8.18% non-reducing sugar. According to Desrosier *et. al*. and Egan *et. al.*, the jam and jelly samples should contain more non-reducing sugars [26,30]. The reason may be due to the addition of sweeteners, which helps obtaining the required texture whereas the conventional ratio of sucrose in jelly is about 60%.

The amount of artificial sugars, salts etc. (other soluble solids) are given in Table 2. From the table, we can see that the maximum amount of sweeteners were present in sample A (18.92%) whereas lowest value was found in Sample H (6.15%).

Sodium benzoate

Sodium benzoate is an antimicrobial agent and it acts as preservative. The role of preservative is that it increases the acidity of a sample so that during storage spoilage of processed food like jam and jelly can be controlled. It hampers yeasts than moulds growth also. Another advantage is that it does not hamper fermentation of lactic and acetic acid. The amount of sodium benzoate used depends on the acidity of the product that needs to be preserved. But BSTI has fixed a value for addition of sodium benzoate and 100mg/kg to be sufficient for preservation [7]. It is observed from Fig.2 that sodium benzoate used in some of the commercial brands is slightly higher than the value fixed by BSTI. Sodium benzoate in excess of 0.1 percent may produce disagreeable burning taste and it may cause adverse effect on health [7]. So care must be taken to use preservatives for longer shelf life.

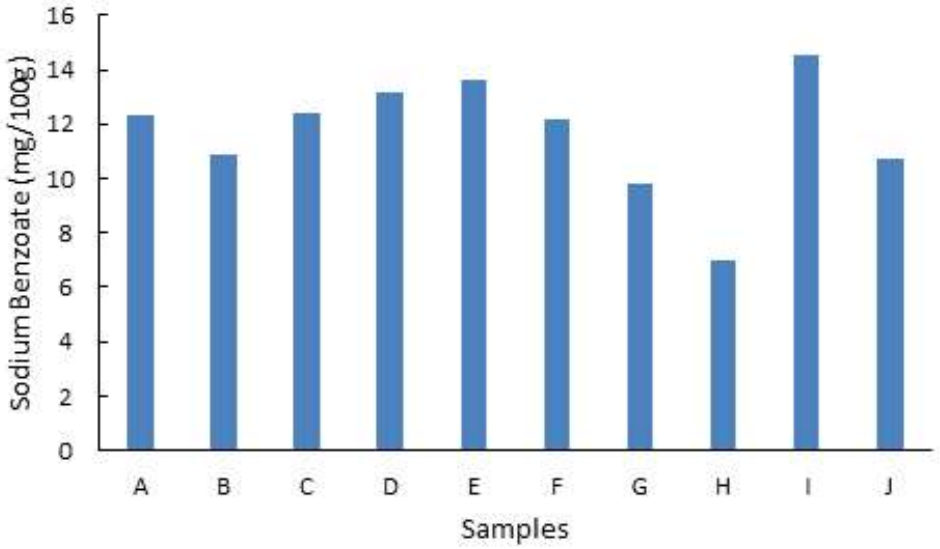


Fig. 2. Amount of sodium benzoate in jam and jelly samples.

Mineral contents

Among the samples analysed, Sample A contained highest amount of sodium, 720 ppm. The lowest amount was found in Sample H and I, 450 ppm. The detection limit for sodium was 0.1 ppm. According to dietary guidelines of FDA, the required amount for sodium intake is between 1500 to 2300 mg per day [31]. This study shows that the samples contain considerable amount of sodium. Among the samples small amount of iron (5.1-9.0 ppm) was found in samples A,B, D, F and G while trace amount of copper (0.30-0.75 ppm) was found in samples B, D, E, F, G and H.

Microbial evaluation

The total plate count and yeast counts are presented in Table 1. According to microbial standards, mould count should not exceed 100cfu/gm [7]. In our study, visible mould was not seen on any sample. The total plate count and yeast count of the samples were below 10 cfu unit. Previous study showed that diverse additives and their measurements were compelling against mould amid 90 days of capacity [32]. Felco *et al*. detailed that sodium benzoate and potassium sorbet decreased microbial count in jam samples and potassium sorbet was more compelling than sodium benzoate [32].

5. Conclusion

In this study, analysis often samples of local jam and jelly of Bangladesh showed that, the physico-chemical and nutrient parameters were performed. The experimental values of pH, total soluble solid, ash, vitamin C, reducing and non-reducing sugar contents were found to be in an acceptable level. No trace of heavy metals (as As, Pb, Cu, Zn and Sn) was found. In the case of preservative, the level of sodium benzoate was found to be comparatively high in the commercial brand jellies. High consumption of food items with high preservative level can weaken the consumer wellbeing. According to physico-chemical and microbial analysis, it was clear that there were no chemical or microbial threat from the selected local jam and jellies.

References

1. M. E. Dauthy, “Fruit and vegetable processing”, *FAO*, pp 1-6, 1995.
2. D. Smith, “Fruit Jellies: Fruit Processing for Entrepreneurs Series”. *NebGuid, University of Nebraska-Lincoln Extension G*, 1604, 2006.
3. W. ed. Jongen, “Fruit and vegetable processing: improving quality”. *Elsevier*, 2002.
4. A. Röhr, K. Lüddecke, S. Drusch, M. J. Müller and R. V. Alvensleben, “Food quality and safety-consumer perception and public health concern”. *Food control*, 16(8), pp 649-655, 2005.
5. A. Askar and H. Treptow, “Quality assurance in tropical fruit processing”. *Springer Science & Business Media*, 2013.
6. G. M. R. Islam and M. M. Hoque, “Food safety regulation in Bangladesh, chemical hazard and some perception to overcome the dilemma”. *International Food Research Journal*, 20(1), pp 47, 2013.
7. K. Sarower, B. Uddin and F. Jubayer, “An approach to quality assessment and detection of adulterants in selected commercial brands of jelly in Bangladesh”. Croatian Journal of Food Technology, *Biotechnology and Nutrition* 10(1-2), pp 50-58, 2015.
8. M. N. Haque, B. K. Saha, M. R. Karim and M. N. H. Bhuiyan, “Evaluation of nutritional and physico-chemical properties of several selected fruits in Bangladesh”. *Bangladesh Journal of Scientific and Industrial Resea*rch, 44(3), pp 353-358, 2009.
9. J. E. Lee, E. J. Choi and M. S. Oh, “Sutdies on Quality

Characteristics of Jeju Mandarin Orange Jelly for the Aged". *Journal of the Korean Society of Food Culture*, 22(4), pp 475-481, 2007.

10. E. T. de Vilela Silva, H. V. Moura, R. M. F. de Figueiredo, A. J. de Melo Queiroz, and I. dos Santos Moreira, "Production and characterization of mixed pineapple and hibiscus jam". *Revista agro@ mbiente on-line*, 13, pp 155-163, 2019.
11. M. Z. Islam, K. Monalisa and M.M. Hoque, "Effect of pectin on the processing and preservation of strawberry (Fragaria ananassa) jam and jelly". *International Journal of Natural Sciences*, 2(1), pp 08-14, 2012.
12. P. Jolhe, G. D. Sahu and V. Kumar, "Preparation and evaluation of guava jelly (Psidium guajava)", *Journal of Pharmacognosy and Phytochemistry*, 9(6), pp 2061-2063, 2020.
13. S. Ranganna, "Handbook of Analysis and Quality Control for Fruit and Vegetable Products", *Tata McGraw-Hill Publishing Company Lt. New Delhi*. P-12-123, 1986.
14. AOAC (Association of Official Analytical Chemists), "Official Methods of Analysis 14.006", *18th edition*, *Washington DC, U.S.A.*, 2005.
15. S. Rangana, "Lane and Eynon Method for Total Sugar Determination". *Handbook of Analysis and Quality Control*, 12-15, 1991.
16. AOAC (Association of Official Analytical Chemists), "Official Methods of Analysis", Centennial edition 1884-1984, *14th edition, Virginia, U.S.A.*, 1980.
17. AOAC (Association of Official Analytical Chemists), "Official Methods of Analysis", P-1094, *15th edition, AOAC inc. Artington Virginia, U.S.A.,* 1990.
18. H. O. Edeoga, D. E. Okwu and B. O. Mbaebie, "Minerals and nutritive value of some Nigerian medicinal plants". Journal of Medicinal and Aromatic Plant Science, 25, pp 1010-1015, 2003.
19. D. R. Osborn and P. Voogt, "Calculation of Calorific Value". In: *The Analysis Of nutrients in Foods. Academic Press, New York*, P-239-240, 1978.
20. O. A. Bessey and C.G. King, "The distribution of vitamin C in plant and animal tissues and its determination". J. Biol. Chem.103, pp 687-698, 1933.
21. A. Mahadevan and R. Sridhar, "Methods in physicological Plant pathology", *2nd Ed., Shivakmi Publication, Madras, India*, P-171, 1982.
22. AOAC (Association of Official Analytical Chemists), "Official Methods of Analysis" 963.19, *17th edition. Association of Official Analytical Chemists, Washington, D.C.*, 2000.
23. APHA (American Public Health Association), "Recommended Methods For The Microbiological Examination Of Foods 2", 1740 Broadway, New York. Pp 205, 1967.
24. P. I. Akubor, "The suitability of African bush mango juice for wine production". *Plant Foods for Human Nutrition*, 49(3), pp 213-219, 1996.
25. M. Ayub, A. Zeb, J. Ullah and M. A. K. Kattak, "Effect of various sweeteners on chemical composition of guava slices". *Sarhad Journal of Agriculture 21(1)*, pp 131-134, 2005.
26. N. W. Desrosier and J. Desrosier, "The technology of food preservation 4". *AVI Publishing Co. Inc. Westport, Connnecticut*, 1978.
27. N. Norman, Potter, "Food science, *2nd edition, The Avi publishing company*, *INC-Westport, Connecticut*, 1976.
28. M. F. Hossain, S. Akhtar and M. Anwar, "Nutritional value and medicinal benefits of pineapple". *International Journal of Nutrition and Food Sciences*, 4(1), pp 84-88, 2015.
29. F. M. Anjum, M. U. Din, I. Ahmad and A.R. Pasha, "Preparation and evaluation of dried apricot diet jam". *Pakistan Journal of Food Science 3(10)*, pp 21-24, 2000.
30. H. Egan, R. S. Kirk and R. Sawyer, "Pearson's Chemical Analysis of Foods 8". *Churchill Livingstone, Longman Group Limited, New York*, 1981.
31. https://www.fda.gov/food/nutrition-education-resources-materials/sodium-your-diet
32. A. S. Falco, J. A. Larrauri, B. Borroto, E. Sevillano and M. Nunez, "Use of combined methods for preserving a concentrated jam obtained from strawberry wastes". *Alimentaria* 30(242), pp 69-71, 1993.