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Pomegranate Jam and Sauce Quality Assessment as a Value Added Products and their Effects on Filled Biscuits Sensory Properties

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ABSTRACT

The aim of this study was to assess the quality of pomegranate jam and pomegranate sauce as value added products, as well as, evaluate their effects on the sensory quality of filled biscuits. Five pomegranate jam formulations and five pomegranate sauces were prepared. Beside, determine the effect of adding cinnamon (0.5% and 1%) and clove (0.5% and 1%) on both pomegranate jam and pomegranate sauce, compared with a control pomegranate jam and pomegranate sauce samples which were processed without adding cinnamon or clove. The final products were then submitted to determine total phenol content, color, consistency and sensorial analysis. The obtained results revealed that the addition of cinnamon and clove to both pomegranate jam and pomegranate sauce improved the total phenol content in comparison with the control samples. Also, samples containing 0.5% cinnamon had a good color, acceptable consistency and sensory properties followed by the control sample for both pomegranate jam and pomegranate sauce. Furthermore, the utilizing of control pomegranate jam, control pomegranate sauce, pomegranate jam and pomegranate sauce with 0.5% cinnamon in filled biscuits gave filled biscuits with good sensory quality criteria.

***Keywords*:** Filled biscuits, Pomegranate, Sauces, Jam, Total phenol, value added product.

Introduction

Pomegranate (*Punica granatum* L.) belongs to the punicaceae family and known as a super fruit of next generation. It has been grown since ancient times for its delicious fruits and as an ornamental garden plant for its red, orange or occasionally, creamy yellow flowers (Schubert *et al.,* 1999).

Pomegranate is considered as a crop of the arid and semi-arid regions because it with stands different soil and climate stresses. It flourishes best under hot dry summer and cold winter provided irrigation facilities are available (Saxena *et al.,* 1987). Popularity of pomegranate is increasing among the growers and consumers worldwide. The edible portion of the pomegranate, shiny red seeds encased in a succulent and edible red pink pulp called arils, is an excellent dietary source as it contains a proportion of organic acids, soluble solids, polysaccharides, vitamins, fatty acids and mineral elements of nutritional significance (Ewaida, 1987, Fadavi *et al.,* 2006).

Pomegranate is a very promising crop because of its refreshing arils, juice and its medical value which regarded as a food medicine of great importance for therapeutic purposes like colic, colitis-diarrhea, dysentery, leucorrhea, paralysis and headache (Schubert *et al.,* 1999, Hertog *et al.,* 1997, Sadeghi *et al.,* 2009). Also, Pomegranate is known for its potential health benefit due to its high antioxidant, anti-mutagenic, anti-hypertension activities and the ability to reduce liver injury (Gil *et al.,* 1996), furthermore, the presence of anti-inflammatory and anti-atherosclerotic effect activity against osteoarthritis, prostate cancer, heart disease and HIV-I. Pomegranate anthocyanin have been demonstrated scavenging activities and the polyphenolic compounds are able to elevate the antioxidant capacity of the human body, strengthening the function of kidney, liver and heart (Malik *et al.,* 2005, Sumner *et al.,* 2005).

About 10-15% of fresh pomegranate produce lose their market value and consumer acceptability due to improper post-harvest management where the fruit disorders such as sun burnt husks, splits and cracks and husk scald on whole fruit reduces marketability and consumer acceptance (Dhinesh and Ramasamy, 2016).

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Jam is an intermediate moisture food containing fruit pulp, pectin, sugar and acid (Santanu *et al.,* 2007), it is an effective and tasty way of preserving fruit and to reduce post-harvest loss in small scale operations (Momin and Thakre, 2015). Also, recently, the consumption of fruit sauces has significantly increased due to new nutritional habits of consumers. For the food industry, sauces are important since they represent products with a high added value, easily manufactured (Mandala *et al.* 2004), they serve as dressings for ice-cream, waffles and cakes, they contain also spices to meet sensory demands (Krystyjan *et al.* 2012).

So, excellent flavor, nutritive value, medicinal properties and post-harvest losses of pomegranate fruit indicates its good potentiality for processing into value added products having extended shelf life, preserved for future time and satisfying the consumer with a high nutritional quality product. Also processing allows the use of the fruits with low quality that cannot be commercialized for the preparation of the new products and help to make it available all over the year. So and according to all of the above mentioned reasons and from value-addition viewpoint, the activity of our research has aimed to the assessment of pomegranate jam and sauce quality as a value add products, as well as, their effect on sensory attributes of filled biscuits as a home food product.

Materials and Methods

Plant material:

The fresh pomegranate (Manfalouty) was used in this study, cultivated in Middle Sinai Research Station (El Maghara in Sinai) - Desert Research Center-Egypt. Pomegranate fruits were washed to remove sand or dirt before halving and scooping out the seeds then cut the pomegranate fruits and collecting the seeds (arils). The pomegranate seeds (arils) were packed in polyethylene bags and stored in refrigerator until processing. Cinnamon powder, clove, sugar, citric acid, wheat flour, butter, baking soda and salt were purchased from local market, Giza, Egypt.

Pomegranate jam processing:

The pomegranate jam was processed according to Sindumathi and Amutha (2014), where the pomegranate seeds (arils) was taken in an open stainless steel pan and a required amount of sugar was added and heated continuously under low flame. When the total soluble solids (TSS) reached 60°Brix, citric acid was added and stirred continuously using a steel ladle. Heating was stopped when the TSS reached 67- 68°bx. The mixture was hot filled into 300 ml previously sterilized glass jars and cooled under ambient conditions. The prepared jam was stored at refrigerated temperature (4°C) until analysis.

Formulation of pomegranate jam:

(PJC): 1Kg pomegranate arils + 750 gm sugar + lemon juice (control treatment).
(PJC5): 1Kg pomegranate arils + 750 gm sugar + lemon juice + 0.5% cinnamon.
(PJC1): 1Kg pomegranate arils + 750 gm sugar + lemon juice + 1% cinnamon.
(PJV5): 1Kg pomegranate arils + 750 gm sugar + lemon juice + 0.5% clove.
(PJV1): 1Kg pomegranate arils + 750 gm sugar + lemon juice + 1% clove.

Pomegranate sauce processing:

Pomegranate sauce is prepared from pomegranate juice by adding sugar (75%), citric acid (0.5g) and then heating the mixture on a slow fire for long period to a thick consistency (Maestre *et al.,* 2000). The sauce was hot filled into 300 ml previously sterilized glass jars and cooled under ambient conditions and stored at refrigerated temperature until analysis (figure 2).

Formulation of pomegranate sauce:

(PSC): 1Kg pomegranate juice + 750 gm sugar + lemon juice (control treatment).
(PSC5): 1Kg pomegranate juice + 750 gm sugar + lemon juice + 0.5% cinnamon.
(PSC1): 1Kg pomegranate juice + 750 gm sugar + lemon juice + 1% cinnamon.
(PSV5): 1Kg pomegranate juice + 750 gm sugar + lemon juice + 0.5% clove.
(PSV1): 1Kg pomegranate juice + 750 gm sugar + lemon juice + 1% clove.

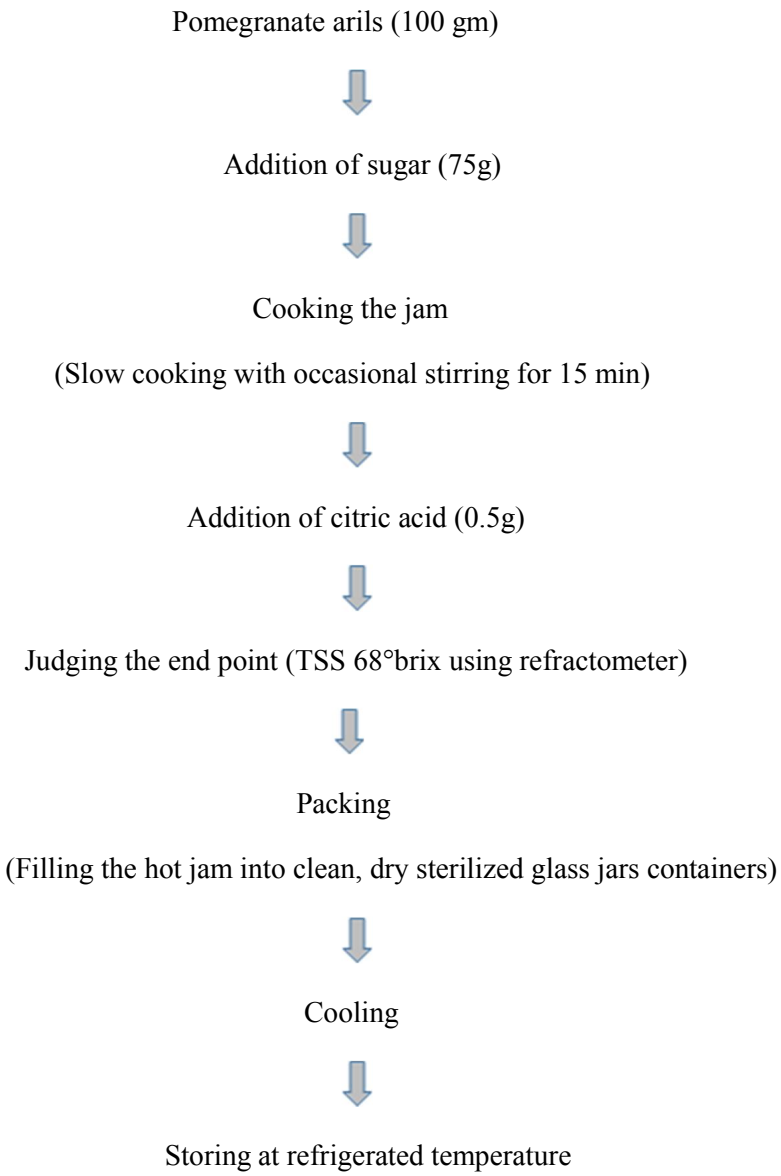

Fig. 1: Flow chart for pomegranate jam preparation.

Filled Biscuits processing:

Filled biscuits were processed as follows, the butter was added into a large mixing bowl with sugar and mix it creaming with an electronic mixer until it has a foamy mixture then the mixture was added to the flour by only adding a little every time, then add half a teaspoon of salt and a teaspoon of baking soda were added and mix it in. knead the mixture, make a flatted ball out of it then it was rolled the dough until a 6mm thick. Biscuits pieces were shaped by using a circle shape cutter, then the biscuits pieces were grouped into two groups. The first group put them on a baking tray with baking paper and put it in an oven (180°C, for 10 min.). The second group of circled biscuits with a tiny circle cut out from the middle were put in a baking tray into the oven. Baking the biscuits for 10 minutes, biscuits samples were cooled for 10 minutes. Both jam or sauce were put on the circle biscuits with no hole and one of the biscuits with a hole on the middle on the tope. (Announ, 2017). The sensory accepted pomegranate jam and sauce samples will be used in the filled biscuits processing.

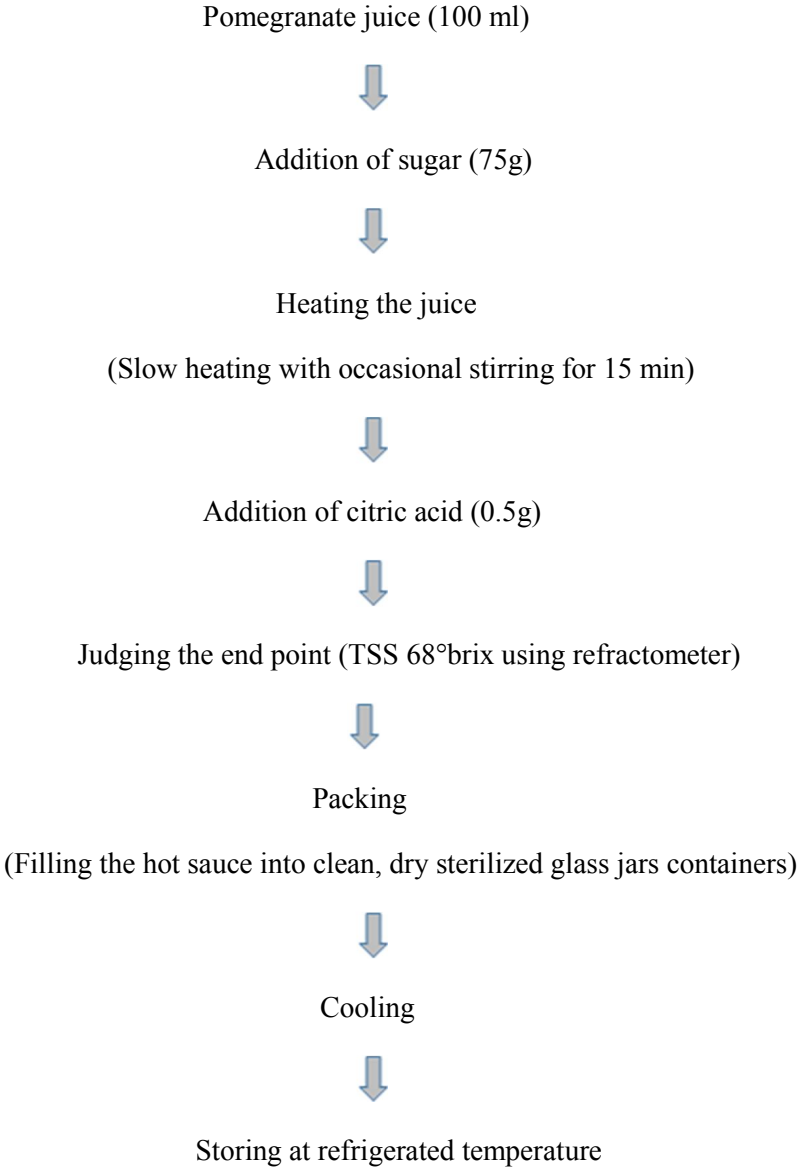

Fig. 2: Flow chart for pomegranate sauce preparation.

Analytical methods:

For the pomegranate jam and pomegranate sauce samples, moisture content was determined according to the methods described in the A.O.A.C. (2000), total soluble solids were determined by using refractometer. Total phenol contents were determined according to Singleton and Rossi (1965), consistency was measured using viscometer, V60002, FFUNGILAB, Spain (Spindle R7) 100 rpm, torque was maintained at 100% at the Food Safety and Quality Control laboratory (FSQC) Faculty of Agriculture, Cairo University. Color was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer at Cairo University Research Park (CURP), Faculty of Agriculture, Cairo university. Color was expressed using the CIE L, a, and b color system (CIE, 1976). A total of three spectral readings were taken for each sample. Lightness (L*) (dark to light), the redness (a*) values (reddish to greenish). The yellowness (b*) value (yellowish to bluish) was estimated.

Sensory evaluation:

In order to characterize the pomegranate jam, sauce and filled biscuits samples at this study, they were analyzed for their sensory profiles. For that, several attributes (color, texture, taste, flavour and an overall acceptability) were evaluated for both pomegranate jam and sauce samples, where color, taste, flavour and overall acceptability attributes were evaluated for the filled biscuits samples. Each of these attributes was rated on a hedonic scale ranging from 1 to 10, where the number 1 corresponded to the lower limit (less intense, less pleasurable), 5 corresponded to the middle limit (middle intense, middle pleasurable) and 10 corresponded to the higher limit (very intense, very pleasurable) according to Guine *et al.,* (2016).

Statistical Analysis:

The data obtained were subjected to statistical analysis of variance (ANOVA). All analyses were performed in triplicate. All tests were conducted at the 5% significant level.

Results and Discussion:

The present study describes the processing of jam and sauce made of pomegranate fruit. Jam and sauce considred to be an effective and tasty way of preserving fruit. Most tropical fruits can be processed and preserved in order to reduce post harvest loss in small scale operations (Momin *and Thakre*, 2015).

Moisture content and total soluble solids of pomegranate jam and pomegranate sauce samples:

Figure (3) shows the values of moisture content (MC) and total soluble solids (TSS) of both pomegranate jam (PJ) and pomegranate sauce (PS) samples. It was found that, the PJ samples had MC ranged from 31.7% (PJC5 sample) to 18.6% (PJV1 sample). For the PS samples, there was a slight of variation in the MC, as the highest significant values found with the PSC1 sample (25.2%) where the lowest values were observed with the PSC5 sample. Generally, the moisture content of foods can be used as an indicator of its shelf life (Fellows, 2000). Low moisture content indicates that the jams have a long shelf life (Naeem *et al.,* 2017).

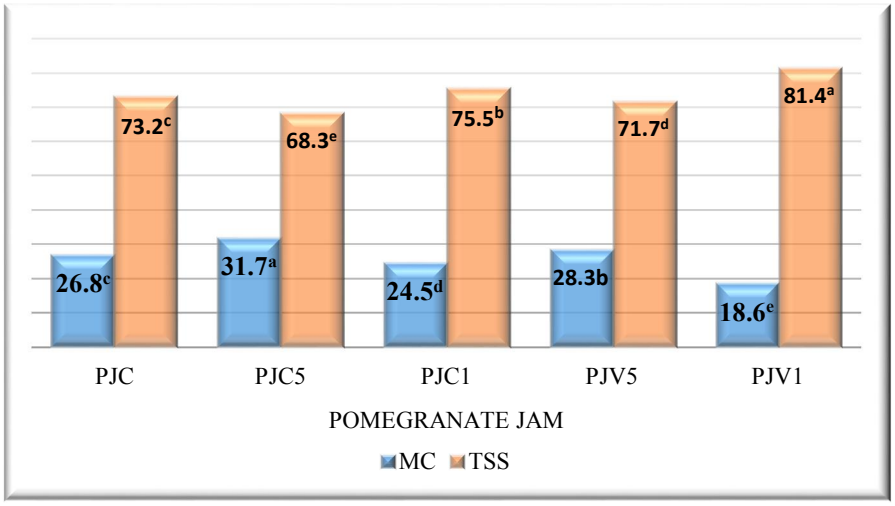

Fig. 3: Moisture content and TSS of pomegranate jam samples.

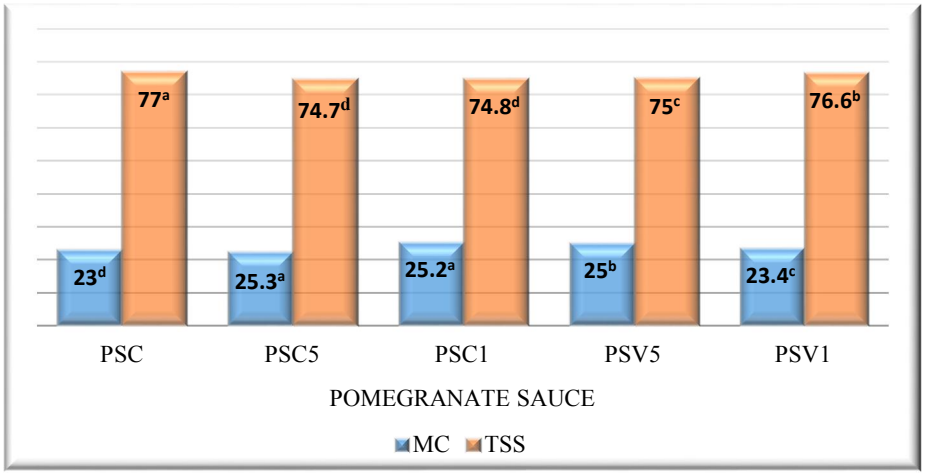

Fig. 4: Moisture content and TSS of pomegranate sauce samples.

TSS of the products was the index of sweetness (Sindumathi and Amutha, 2014). Figure (4) displays the values of TSS of both PJ and PS samples. There was a significant difference in the TSS values. The TSS values of the PJ samples was 81.4, 75.5, 73.2, 71.7 and 68.3 °brix for PJV1, PJC1, PJC, PJV5 and PJC5 samples, respectively. The TSS values of the PS samples was found highest with the PSV1 sample (76.6°brix), whilst, the lowest values observed with PSC5 sample (74.7°brix). Taufik and Karim (1992) who reported that maintaining of 68 to 70% Brix not only gives taste but also protect jam from deterioration since microorganisms can not grow at 70% sugar concentration. Dhinesh and Ramasamy (2016) mentioned that the pomegranate sauce (Ana Rub) has TSS ranging from 70 to 75 %. Devi *et al.* (2017) mentioned that the increase in TSS contents was due to loss of moisture.

Total phenol (TP) of pomegranate jam and pomegranate sauce samples:

The potent antioxidant activities of pomegranates are attributed to its polyphenols (Seeram *et al.,* 2005). All the thermal treatment methods affected the total phenolic content and antioxidant properties (Chipurura *et al.,* 2010). So it was important to determine the total phenol content for both PJ and PS samples. Figure (5) demonstrates the total phenol of both PJ and PS samples. There was a significant deference in the TP values for both PJ and PS samples. For the PJ samples, the PJC1 sample possessed a high significant TP value (271.4 mg GAE/100gm) followed by PJV1 (247.4 mg GAE/100gm), PJC5 (237.6 mg GAE/100gm), PJV5 (222.1 mg GAE/100gm) and 188.8 mg GAE/100gm for the PJC sample. On the other hand, figure (5b) displays that, the PSC1 and PSC5 exhibited the highest significant TP values (269.2 mg GAE/100gm and 252.4 mg GAE/100gm), respectively, followed by the PSV1 (226.9 mg GAE/100gm), PSV5 (216.2 mg GAE/100gm) and (198.8 mg GAE/100gm) for the PSC sample.

Our findings revealed that, both PJC and PSC samples supposed to have a respectable TP content and this is due to that the pomegranate fruit considered to be a good source of phenolic compounds. Furthermore, it was concluded that the addition of cinnamon and cloves enhanced the TP content of both PJ and PS samples in comparison with the control samples and so extends the shelf life of them. Moreover, as the percentage of cinnamon and clove increase as the TP content increase for the PJ samples, where, the TP increment rate in the PS samples containing cinnamon was more than the TP increment rate in PJ and PS samples containing clove. Gupta (2013) illustrated that cloves and cinnamon have an excellent anti-oxidant potential activity due to the presence of high phenolic contents. The potential health benefits of cinnamon derived primarily from bioactive ingredients such as polyphenols (Vidanagamage *et al.,* 2016 and Jakhetia *et al.,* 2010).

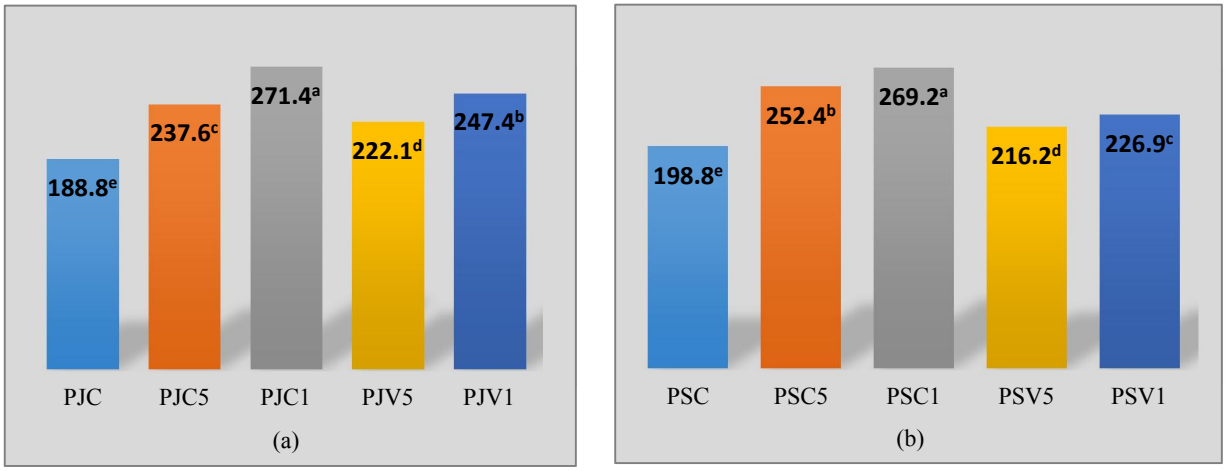

Fig. 5: Total phenol content (mg GAE/100g) of pomegranate jam (a) and pomegranate sauce (b) samples.

Color of pomegranate jam and pomegranate sauce samples:

Table (1) shows the mean values of lightness/darkness (L*), redness (a*), yellowness (b*) for both PJ and PS samples. The higher L* values was observed with the PJC samples (27.8) followed by PJC5 and PJV5, where the lower values were obtained with the PJV1 and PJC1, respectively. As the L* value decrease as the darkness of the jam increase and so, both PJC1 and PJV1 samples are darker than the PJC5 and PJV5 samples. The data for a* values were ranged from 13.24 with the PJC sample to 8.76 for the PJC5 sample where the b* values ranged from 6.56 to 3.42 for PJC and PJC5 samples, respectively. On the other hand, with the PS samples, the higher L* values were observed with the PSC samples followed by PSV5, PSC5, PSV1 and PSC1, respectively. The highest significant a* value was found with PSV1 and PSV5 samples followed by the PSC sample, where both PSC5 and PSC1 samples recording the smallest a* values. With respect to b* data, the PSC samples had the greater values (12.9) where the smallest b* value was reported with PSC5 samples with lower yellowness.

Table 1: Color of Pomegranate jam and Pomegranate sauce.

Color parameter	Pomegranate jam					Pomegranate sauce				
	PJC	PJC5	PJC1	PJV5	PJV1	PSC	PSC5	PSC1	PSV5	PSV1
L*	27.8^{a}	27.8^{a}	25.0^{b}	27.6^{a}	26.2^{b}	35.2^{a}	29.9^{c}	28.1^{d}	31.56^{b}	29.78^{c}
a*	13.24^{a}	8.76^{b}	12.64^{a}	8.99^{b}	12.98^{a}	9.5^{b}	7.65^{d}	6.76^{c}	9.91^{b}	10.58^{a}
b*	6.56^{a}	4.69^{c}	3.42^{d}	4.39^{c}	5.53^{b}	12.9^{a}	1.9^{e}	2.54^{d}	3.99^{c}	6.83^{b}

(PJC) the control pomegranate jam, (PJC5) pomegranate jam with 0.5% cinnamon, (PJC1) pomegranate jam with 1% cinnamon, (PJV5) pomegranate jam with 0.5% clove, (PJV1) pomegranate jam with 1% clove, (PSC) the control pomegranate sauce, (PSC5) pomegranate sauce with 0.5% cinnamon, (PSC1) pomegranate sauce with 1% cinnamon, (PSV5) pomegranate sauce with 0.5% clove, (PSV1) pomegranate sauce with 1% clove. Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$

The darkening in jam or sauce color may be due to the thermal process which promotes pigment degradation and consequent darkening of the product as reported by Lespinarda *et al.* (2012), or due to effect of the addition of cinnamon and clove, where, as the concentration of cinnamon and clove increase as the jam and sauce color get darker.

Consistency of pomegranate jam and pomegranate sauce samples:

The consistency measurement of food product is much useful behavioral and predictive information to take guidelines in formulation, processing and product development (Shahnawaz and

Shiekh, 2011). Consistency of both PJ and PS samples were performed in figure (6). The results showed that the PJC5 sample appeared to have the lowest consistency values in comparison with the other PJ samples (figure 6a). Also, it was seen from figure (6b) that the consistency of PSC5 and PSC1 samples were higher than the PSV1, PSC and PSV5, respectively. The increment rate in the consistency observed with the PSC samples may be due to the powder nature of cinnamon which lead to raising in the consistency of the sauce samples in comparison with the other samples.

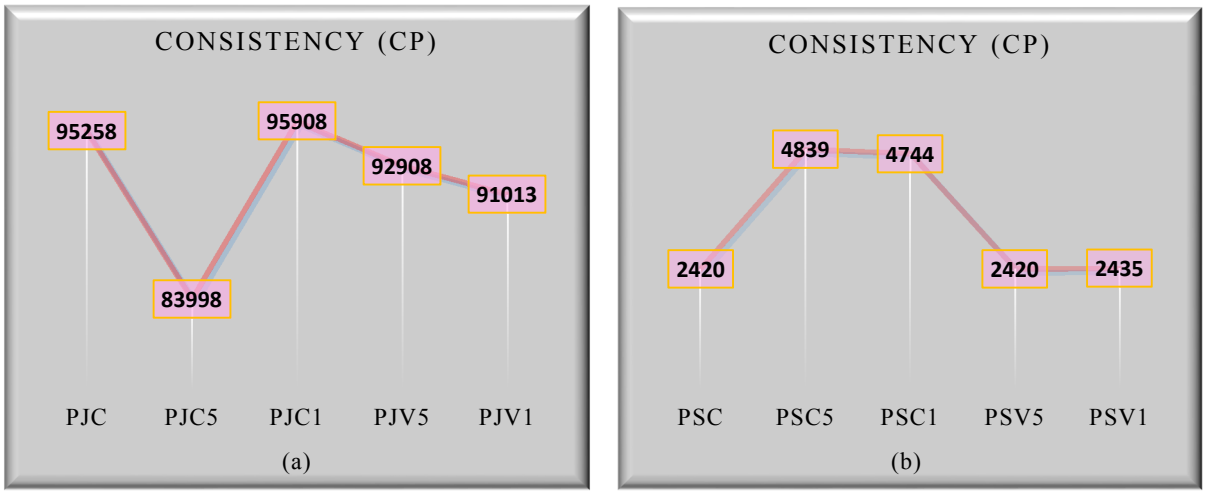

Fig. 6: Consistency of pomegranate jam (a) and pomegranate sauce (b) samples.

Sensory properties of pomegranate jam, pomegranate sauce and filled biscuits samples:

Consumer acceptance for the PJ, PS and filled biscuits samples was done by sensory analyses. As presented in table (2), the results confirmed that the pomegranate seeds were having to be accepted by the panelists. The PJC5 is set to be the most appreciated sample with a higher score in all sensory attributes followed by PJC samples. The PJC1, PJV5 and PJV1 were confirmed as less valued, with the lowest scores in most of the sensory attributes evaluated and no significant differences between the overall acceptability scores. Also data in table (2) display the sensory attributes of PS samples. The lowest significant color score observed with the PSC1 samples where there are no significant differences in color among the other PS samples. For the taste and flavour attributes, the PSC5 and PSC samples were found to be the most preferred samples. The higher accepted texture score was found with the PSC5 and PSC1 samples. With regard to the PSV5 and PSV1 samples, the most appreciated sensory attributes were flavour and color whilst the less scored attributes were taste and consistency.

Table 2: Sensory properties of Pomegranate jam and Pomegranate sauce samples.

Sensory properties	Pomegranate jam					Pomegranate sauce				
	PJC	PJC5	PJC1	PJV5	PJV1	PSC	PSC5	PSC1	PSV5	PSV1
Color	9.3^{a}	9.6^{a}	8.7^{b}	9.0^{b}	8.9^{b}	9.0^{a}	9.3^{a}	8.5^{b}	9.2^{a}	9.0^{a}
Taste	9.3^{a}	9.5^{a}	8.8^{b}	8.4^{c}	8.5^{c}	9.1^{b}	9.5^{a}	8.8^{c}	8.1^{d}	8.3^{d}
Flavour	9.3^{a}	9.6^{a}	8.5^{b}	9.0^{a}	8.5^{b}	9.2^{b}	9.6^{a}	8.9^{b}	9.1^{b}	8.8^{b}
Texture	8.1^{b}	8.9^{a}	7.9^{b}	7.7^{c}	7.8^{b}	8.1^{b}	9.5^{a}	9.3^{a}	7.9^{b}	7.7^{b}
Overall acceptability	9.0^{b}	9.6^{a}	8.6^{b}	8.8^{b}	8.6^{b}	9.0^{b}	9.5^{a}	8.5^{c}	7.7^{d}	7.5^{d}

(PJC) the control pomegranate jam, (PJC5) pomegranate jam with 0.5% cinnamon, (PJC1) pomegranate jam with 1% cinnamon, (PJV5) pomegranate jam with 0.5% clove, (PJV1) pomegranate jam with 1% clove, (PSC) the control pomegranate sauce, (PSC5) pomegranate sauce with 0.5% cinnamon, (PSC1) pomegranate sauce with 1% cinnamon, (PSV5) pomegranate sauce with 0.5% clove, (PSV1) pomegranate sauce with 1% clove. Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$

Concerning the overall acceptability attributes, the higher scores were observed with the PSC5 and PSC samples which found to be the most preferable samples. Moreover, the pomegranate seeds were having to be accepted for the panelist and so it makes the pomegranate jam a good value added product.

Usage of PJ and PS in filled biscuits processing were under taken in order to evaluate its effect on the sensory attributes of the filled biscuits as a home food product. The PJC, PJC5, PSC and PSC5 which were the most acceptable samples in sensory evaluation of PJ and PS samples are used in the filled biscuits processing. From table (3), it has been noticed that both PJ and PS samples were extremely liked by the panelists. Over and above, the pomegranate seeds dose not affected the filled biscuits eating quality where there was a good eating harmony in the biscuits filled with PJ samples.

Table 3: Sensory properties of filled biscuits.

Sensory properties	Pomegranate jam filled biscuits		Pomegranate sauce filled biscuits	
	PJCFB	PJC5FB	PSCFB	PSC5FB
Color	9.3^{b}	9.6^{a}	9.2^{a}	9.3^{a}
Taste	9.3^{a}	9.5^{a}	9.4^{a}	9.6^{a}
Flavour	9.3^{b}	9.6^{a}	9.3^{b}	9.6^{a}
Overall acceptability	9.5^{a}	9.6^{a}	9.5^{a}	9.5^{a}

(PJCFB) the control pomegranate jam filled biscuits, (PJC5FB) the filled biscuits with pomegranate jam (0.5% cinnamon), (PSCFB) the control pomegranate sauce filled biscuits, (PSC5FB) the filled biscuits with pomegranate sauce (0.5% cinnamon).
Mean value ± Standard deviation of three replicates, means sharing the same letter in a raw are not significantly different at $p \geq 0.05$

Conclusion

Our findings clarified that the pomegranate jam and pomegranate sauce were found to be excellent value added preserved products. Furthermore, the addition of cinnamon and clove with 0.5% improve the total phenolic content. Also, amongst the prepared samples, the control pomegranate jam, control pomegranate sauce, pomegranate jam and sauce samples with 0.5% cinnamon were found to be the most preferable samples with good color, consistency and sensory properties. Also, both pomegranate jam and pomegranate sauce reinforcement the filled biscuits sensory properties.

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