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Evaluation of Jam Developed from Low-Quality Pickled Green Olives

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ABSTRACT

The present study was implemented to look into the possibility of developing jam from the low-quality green olive pickle (GOP). Therefore, three types of olive jam were prepared from the whole GOP fruits with cinnamon (WCJ), whole GOP fruits with fig fruits (WFJ), slice GOP fruits with cinnamon (SCJ), slice GOP fruits with fig fruits (SFJ), minced GOP fruits with cinnamon (MCJ) and minced GOP fruits with fig fruits (MFJ). Three control jam samples were prepared from whole GOP fruits (CW), slice GOP fruits (CSJ) and minced GOP fruits (CMJ) without adding cinnamon or fig fruits. Sensory quality of the GOP jam samples was evaluated to assess the most accepted olive jam samples. Chemical composition, titratable acidity, pH, total soluble solids, color, consistency, total phenolic content and antioxidant activity were determined for the accepted olive jam samples. Sensory results revealed that the CSJ, SCJ, SFJ, CMJ, MC and MFJ exhibited accepted sensory attributes score and good chemical composition property. Likewise, titratable acidity and total soluble solids values were ranged from 0.57 to 0.7% and 65 to 70 °brix, respectively, among all accepted GOP jam samples. Color of SGOP jam samples found to be darker than MGOP jam samples. MOGP jam samples exhibit higher consistency than SGOP jam samples. Moreover, it was noticed that adding cinnamon powder and fig fruits enhanced both total phenolic content and antioxidant activity. Therefore, low-quality green olive pickle could be reused and developed into jam with a good characteristic.

Keywords: Olive pickle, olive jam, reuse, cinnamon powder, fig fruits, total phenol, titratable acidity, antioxidant activity

1. Introduction

Achieving agricultural sustainability and ensure remunerative price of the agricultural products is to make it more marketable. Food processing adds value enhances the shelf life of the perishable agro-food products and ensure the marketable of the agricultural product. Moreover, value-added food processing products is something that you do to help earn more money from your farm and produce more appealing consumers products.

Olive tree (*Olea europaea* L) is widely grown in the Mediterranean area, it is a perennial fruit trees that are evergreen and its cultivated spread in most desert areas in Egypt which represents one of the most important crops in these zones. Its fruit is a drupe that is used for both oil extraction and table olive purposes (Beltran *et al.,* 2004). Olive crop is one of the most important agricultural crops in Siwa Oasis, Matrouh Governorate, whose fruits are well known by their high nutritional value because they contain carbohydrates, protein, mineral salts, cellulose, and various vitamins, in addition to their high content of oil, which contains Fatty acids which important in vital functions that occur in the human body (Attia and Abu Al-Naga, 2021). Cultivation of olive is primarily for oil and table olive products (Burns *et al.,* 2008).

Pickling olive considered to be one of the ways used for preserving olive fruit and obtain table olive which considered to be an important appetizer. Nutritional value of table olives is due to its richness in monounsaturated fat, mainly oleic acid, vitamin E with the presence of several

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phytochemicals (Rocha *et al.,* 2020). The carbohydrate content in the olive fruit is lower than any other edible fruit due to their loosing during fermentation process (Marsilio *et al.,* 2001), moreover are a good source of dietary fiber which has a high digestibility rate (Jimenez *et al.,* 2000; López-López *et al.,* 2007). Lipids are the major component of table olives with an overall range of 6–30 % (Boskou, 2017). Quality of table olive depend on the good quality of raw olive fruit used in pickling process, pickling process circumstances especially fermentation time and sensory properties (El Sorady, 2010).

Jam is a semi-solid food product, prepared by cooking sugar with fruits or vegetables pulp, pectin, acid and other ingredients to a sensibly consistency and it should contain 65% or more TSS and at least 45% pulp (Awulachew, (2021). Jam is an ancient and tasty way of preserving fruit and vegetable where the high sugar content of jam does not allow bacteria, yeast and molds to grow (Ashaye and Adeleke, 2009). Meanwhile, Jam is an alternative to using fruits to make products with good nutritional and economic value (Saputro *et al.*, 2018).

Moreover, jam has the ability to process under small scale food production system and offers wastage minimization and value addition in the same time (Momin and Thakre, 2015), so, it could offer a generate in income and employment in countries of agrarian economy. Cinnamon bark is widely used for its organoleptic features in food products due to its beneficial effect on human health, it is rich in antioxidant, anti-inflammatory and anticancer biomolecules (Pagliari *et al.*, 2023).

At the end of pickling process, table olives are graded for the good symmetry color and size and then packed into salty or vinegar fresh brine for costumers. Variation in color, shape, shrinkage, softening, blemished of the table olives fruit is an undesirable grade with a low sensory quality which become a low marketing quality olive pickle and considered to be a waste from the olive pickle manufacture. Therefore, the aim of this study was trying to benefit the low marketing quality olive pickle by converting them into unconventional value-added product. So, the research centered on the possibility of process jam from the low marketing olive pickle by look into the effect of fruit shape involved into jam process, as well as, effect of adding cinnamon powder and fig fruits on the sensory properties, chemical composition, titratable acidity, total soluble solids, color, consistency, total phenolic content and antioxidant activity on the jam the processed quality.

2. Materials and Methods

Materials

Green olive pickle (GOP) was purchased from local market in Siwa Oasis. Fig fruits was purchased from local market Marsa Matrouh, Matrouh governorate. Sugar, cinnamon and citric acid were purchased from local market, Giza, Egypt.

Methods

Preparation of GOP for jam processing

The GOP stone had been removed and fruits were soaked in tap water for 3 days in order to reduce their saltiness, the soaking water is changed every day. After that, the GOP have been divided into three groups for jam processing, the first group used the whole GOP fruit (WGOP). The second group, the GOP have been cut into slice (SGOP), where the third group used the GOP in a minced shape (MGOP). All samples were packed in polyethylene bags and stored in refrigerator until processing.

Jam processing

Jam processed according to Elsorady and Abdelrasoul, (2012). The three groups of GOP samples were taken in an open stainless-steel pan and boiled in water (1:1 w/v). A required amount of sugar was added, 1000 g of GOP flesh with 1000 g of sugar and heated continuously under low flame. When the total soluble solids (TSS) reached 60°Brix, 1 g of citric acid was added and stirred continuously. Jam samples were cooked till required TSS (68 - 70 °Brix). The jam was hot-packed in glass jars, closed tightly and cooled under ambient conditions then stored at refrigerated temperature (4°C) until analysis.

Formulation of different GOP jam samples were as follows:

- CWJ: 1Kg of WGOP + 1Kg sugar + 1 gm citric acid (control treatment).
- WCJ: 1Kg of WGOP + 1Kg sugar + 1 gm citric acid + 0.5% cinnamon.
- WFJ: 1Kg of WGOP + 1Kg sugar + 1 gm citric acid + 1kg fig fruits.
- CSJ: 1Kg of SGOP + 1Kg sugar + 1 gm citric acid (control treatment).
- SCJ: 1Kg of SGOP + 1Kg sugar + 1 gm citric acid + 0.5% cinnamon.
- SFJ: 1Kg of SGOP + 1Kg sugar + 1 gm citric acid + 1kg fig fruits.
- CMJ: 1Kg of MGOP + 1Kg sugar + 1 gm citric acid (control treatment).
- MCJ: 1Kg of MGOP + 1Kg sugar + 1 gm citric acid + 0.5% cinnamon.
- MFJ: 1Kg of MGOP + 1Kg sugar + 1 gm citric acid + 1kg fig fruits.

Sensory evaluation

All olive jam samples were estimated for their sensory properties in order to select the best or accepted jam samples. Therefore, color, texture, taste, odor and overall acceptability were evaluated for all jam samples. Each of these attributes was rated using 10-point scale for grading the quality of samples according to Guine *et al.* (2016).

The accepted jam samples were subjected to the following analytical methods

Chemical composition was estimated in terms of moisture content, ash, crude protein, crud fiber and ether extract according to A.O.A.C., (2005), total carbohydrates were determined by differences. Calorie values were calculated according to Stilinović *et al.* (2020) using the following equation:

$$\text{Calorie value (kcal/100 g)} = (\%\ \text{carbohydrate} \times 4) + (\%\ \text{protein} \times 4) + (\%\ \text{fat} \times 9).$$

Titratable acidity was determined according to Paul *et al.* (2010) by titrating 10g crushed sample dissolved in 50ml distilled water, then filtered and titrated by 0.1N NaOH solution using phenolphthalein as an indicator, to pink end point persisting for 30 seconds.

Total soluble solids were determined by measuring the °Brix at 20 °C with a portable Refractometer model (Hand held refractometer REF 101/111).

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.

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.

Total phenolic content was estimated colorimetry by Folin–Ciocalteu reagent according to Singleton and Lamuela-Raventos, (1999) and were expressed as mg gallic acid equivalent /100g sample.

Antioxidant activity was determined using the DPPH radical scavenging activity, where the free radical scavenging activity of the extracts against DPPH (1,1-diphenyl-2 picrylhydrazyl) free radical was estimated as described by Brand-Williams *et al.,* (1995). Concentration ranging from 30, 100 and 150 mg/ml were prepared with methanol from each sample. The extract (100µl) and DPPH radical (100 µl, 0.2 mM) dissolved in methanol. The mixture was stirred and left to stand for 15 min. in dark then the absorbance was measured at 517 nm against a control which carried out using 2 mL DPPH solution without the test sample. The DPPH radical scavenging ability was subsequently calculated as follows:

$$\text{DPPH radical scavenging ability (\%)} = (Ac - At)/Ac \times 100.$$

Where Ac: absorbance of control. At: absorbance of samples.

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 (Armonk, 2011).

3. Results and Discussion

3.1. Chemical composition of fresh green olive pickle

Data in table (1) represented the chemical composition of fresh green olive pickle, where values of moisture content and total ash were 84 and 5.2%, respectively. Crude protein, crude fiber and ether extract scored 2.03, 5.48, 2.68%, respectively. Total carbohydrates were found to be 0.61%. Abd El-Fadeel *et al.* (2010) illustrated that Protein content of Egizi Shami olive pickled was 1.81 %. López-López *et al.* (2010) mentioned that moisture content of table olives ranged from 60 to 81%, crude protein level is low and ranged from 1.0 to 2.2 % and traces of total carbohydrate content in table green olives since during the fermentation process the microorganisms present in brines consume sugars. Boskou, (2017) explained that lipids component in table olives ranged of 6–30%. Table olives are a good source of dietary fiber, which in addition, has a high digestibility rate (Jimenez *et al.*, 2000 and López-López *et al.*, (2007).

Table 1: Chemical composition of fresh green olive pickle (on wet weight basis).

Chemical composition (%)	Values
Moisture content	84±0.10
Total ash	5.2±0.02
Crude protein	2.03±0.1
Crude fiber	5.48±0.06
Ether extract	2.68±0.20
Total carbohydrates*	0.61±0.04
Calorie value (Kcal/100g)	34.68±0.02

Data are mean ± Standard deviation, *Calculated by differences.

3.2. Sensory evaluation of olive jam samples

Data in table (2) demonstrated the sensory properties of GOP jam samples. There was a significant difference among the color, taste, texture, flavor and overall acceptability of all jam samples under investigation concerning color is an important parameter that determine consumers acceptance, where it affect the external appearance of the food product (Perez-Lopez, 2010). The highest mean color value was found with the MFJ and MCJ, where the lowest mean color values were observed with the whole green olive pickle (WGOP) jam samples. Changes in color might be due to Millard reaction, enzymatic browning ascorbic acid degradation and polymerization of color pigments with another phenolic compound resulted in change in jam color (Touati *et al.,* 2014 and Wasif *et al.,* 2015).

For taste and texture parameters, the WGOP jam samples scored lower mean values followed by slice green olive pickle (SGOP) jam samples then minced green olive pickle (MGOP). In case of odor parameter, all jam samples prepared with adding cinnamon or mixed with fig fruits have been scored a high odor mean value when compared with all control jam samples. Regarding overall acceptability, the lower mean values were scored with the WGOP jam samples, where the panelist totally dislike the WGOP jam samples, whilst the MGOP jam samples recorded the highest mean overall acceptability values followed by SGOP jam samples. Shokry *et al.* (2018) mentioned that pomegranate jam containing 0.5% cinnamon had a good sensory property. Wasif *et al.* (2015) noted that all the sensory parameters of apple olive blended jam were enhanced as the percentage of apples in jam preparation increased. Therefore, based on the sensory evaluation, all the WGOP jam samples were rejected, moreover, using cinnamon and fig fruit enhanced the sensory properties of GOP jam. In the same time the most accepted jam samples were (CSJ) control slice GOP jam, (SCJ) slice GOP jam with 0.5% cinnamon, (SFJ) slice GOP jam with fig fruits, (CMJ) control minced GOP jam with fig fruits, (MCJ) minced GOP jam with 0.5% cinnamon, (MFJ) minced GOP jam with fig fruits.

Table 2: Sensory properties of olive jam samples.

Olive jam samples	Sensory parameters				
	Color	Taste	Texture	Odor	Overall acceptability
CWJ	7.67^{c}±0.30	7.17^{d}±0.28	6.67^{f}±0.28	7.50^{c}±0.28	6.70^{e}±0.28
WCJ	8.33^{b}±0.30	7.17^{d}±0.28	7.17^{e}±0.28	7.83^{b}±0.28	7.20^{d}±0.28
WFJ	8.50^{b}±0.50	7.83^{c}±0.28	7.67^{c}±0.20	8.00^{b}±0.00	6.70^{e}±0.30
CSJ	8.67^{a}±0.28	8.17^{b}±0.30	7.33^{d}±0.30	7.50^{c}±0.50	7.83^{c}±0.28
SCJ	8.80^{a}±0.26	8.16^{b}±0.30	7.83^{b}±0.20	8.33^{a}±0.28	8.20^{b}±0.28
SFJ	8.67^{a}±0.30	8.17^{b}±0.00	8.00^{b}±0.00	8.33^{a}±0.28	8.33^{b} ±0.28
CMJ	8.67^{a}±0.30	8.50^{b}±0.00	8.17^{b}±0.20	8.80^{a}±0.30	8.50^{b}±0.00
MCJ	9.16^{a}±0.30	9.17^{a}±0.30	8.70^{a}±0.28	8.80^{a}±0.28	9.00^{a} ±0.28
MFJ	9.16^{a}±0.30	9.33^{a} ±0.30	9.00^{a}±0.00	9.00^{a}±0.28	9.20^{a} ±0.28

(CWJ) control whole GOP jam, (WCJ) whole GOP jam with 0.5% cinnamon, (WFJ) whole GOP jam with fig fruits, CSJ) control slice GOP jam, (SCJ) slice GOP jam with o.5% cinnamon, (SFJ) slice GOP jam with fig fruits, (CMJ) control minced GOP jam with fig fruits, (MCJ) minced GOP jam with 0.5% cinnamon, (MFJ) minced GOP jam with fig fruits. Mean value ± Standard deviation of replicates, means sharing the same small letter in a column are not significantly different at p≥0.05.

3.3. Chemical composition of olive jam samples

The chemical composition of olive jam samples was investigated and data was presented in table (3). There was no data about the chemical composition of olive jam, therefore, all of comparisons were made with results obtained on other fruits jam. There was significantly (p≤0.05) difference between olive jam samples in all chemical composition parameters. Maximum mean value of moisture content was appeared with SFJ and MFJ samples (31.53 and 31.10%), respectively, without significant (p≥0.05) difference, followed by CMJ, MCJ, CSJ and SCJ with 29.36, 27.54, 26.32 and 24.28% moisture content values, respectively. It could be noticed that, the moisture content of the both SCJ and MCJ was the lowest among in both MGOP and SGOP followed by CMJ and CSJ, however the SFJ and MFJ were recognized to have the highest moisture content, which mean that, adding cinnamon decreased the moisture content of olive jam, while adding fig fruits increased olive jam moisture content. Moreover, the moisture content of all jam samples ranged from 24.28% to 31.53%.

Moisture content has a greater impact on the shelf life of food products (Eke-Ejiofor and Owuno, 2013). Jam moisture content affected by the concentration of food nutrients and heating process during jam processing (Saka *et al.,* 2007 and Suman *et al.,* 2021). Chalchisaa *et al.,* (2022) mentioned that the moisture contents of pineapple jam samples were ranged from 29.23% to 32.98% and also stated that the moisture content of commercially produced jam was ranged between 31.23% to 33.36% on average. Pandiangan *et al.*, (2023), found that using cinnamon powder with 0.6 and 0.9% decreased the moisture content of banten banana jam and clarified the cause because of cinnamon powder has a hygroscopic property which led to bound water and forming gel. Finally, the moisture content of all olive jam samples appears to have a good shelf life as their moisture contents were found in range with that of commercially available jam in the market.

Ash considered to be an indicator of the total amount of mineral presence in food product and low ash content means low in minerals content. The highest significantly (p≤0.05) total ash content recorded with MFJ sample (1.92%), whilst MCJ (1.70%) sample appeared to had the lowest significantly (p≤0.05) total ash content. Data for total ash of SCJ and MCJ samples were higher than those observed with Pandiangan *et al.* (2023), who stated that banten banana jam with 0.9% cinnamon powder contain 1.6% total ash. Ho *et al.* (2020) reported that variation in total ash content was attributed to the losses of minerals during washing and jam cooking, also, mentioned that alteration in protein content may be due to loss of some nitrogen compounds during processing by heating. Dandago, (2009) demonstrated that leaching of minerals into the water during preparation of raw materials or processing occurred caused a significant reduction in ash content.

Regarding crude protein content, the CMJ and MFJ found to have a crude content values 1.36 and 1.33%, respectively, followed by CSJ sample (1.20%), while both SCJ and MCJ stated the same crude protein value (1.10%). There was a decrement in crude fiber content in olive jam samples contain cinnamon and fig fruits as compared to CMJ and CSJ samples. Also, crude fiber content of MGOP jam samples were slightly more than crude fiber content of SGOP jam samples. Crude fiber content was 3.33 and 3.22 % with CMJ and CSJ samples, respectively, whereas crude fiber content was 3.20 and 3.10 % with MFJ and MCJ samples, respectively. The crude fiber content of both SFJ and SCJ samples was 3.00 and 2.80%, respectively.

Table 3: Chemical composition of olive jam samples (on wet weight basis).

Chemical composition (%)	CSJ	SCJ	SFJ	CMJ	MCJ	MFJ
Moisture content	26.32^{c}±0.12	24.28^{d}±0.3	31.53^{a}±0.43	29.36^{b}±0.05	27.54^{c}±0.60	31.10^{a}±0.30
Total ash	1.72^{c}±0.02	1.81^{b}±0.02	1.80^{b}±0.02	1.77^{b}±0.07	1.70^{c}±0.03	1.92^{a}±0.07
Crude protein	1.20^{b}±0.09	1.10^{c}±0.35	1.03^{c}±0.21	1.36^{a}±0.05	1.10^{c}±0.03	1.33^{a}±0.04
Crude fiber	3.22^{a}±0.06	2.80^{c}±0.03	3.00^{b}±0.07	3.33^{a}±0.30	3.10^{b}±0.02	3.20^{b}±0.05
Ether extract	6.61^{a}±0.24	6.22^{b}±0.15	6.62^{a}±0.18	5.30^{c}±0.12	4.76^{d}±0.13	4.09^{e}±0.09
Total carbohydrates*	60.93^{c}±0.04	63.79^{a}±0.03	56.02^{e}±0.73	58.88^{d}±0.35	61.80^{b}±0.50	58.36^{d}±0.41
Calorie value Kcal/100g)	308.01^{b}±0.02	315.54^{a}±0.01	287.78^{d}±0.01	288.66^{d}±0.03	294.44^{c}±0.40	275.57^{e}±0.10

(CSJ) control slice GOP jam, (SCJ) slice GOP jam with o.5% cinnamon, (SFJ) slice GOP jam with fig fruits, (CMJ) control minced GOP jam with fig fruits, (MCJ) minced GOP jam with 0.5% cinnamon, (MFJ) minced GOP jam with fig fruits. Mean value ± Standard deviation of three replicates, means sharing the same small letter in a raw are not significantly different at p≥0.05.

Moreover, data in table (3) clarified the ether extract content of olive jam samples. The SGOP jam samples recorded mean ether extract content higher than MGOP jam samples. The highest significant (p≤0.05) ether extract content displayed with CSJ and SFJ samples, followed by SCJ sample, with regard to SGOP jam samples. Revealed to MGOP jam samples, CMJ logged the highest mean ether extract content (5.30 %) which come before MCJ sample (4.76%) and MFJ sample (4.09%). Decrement in ether extract content in olive jam samples may be due to the mincing of olive fruit which does not enhance by adding cinnamon or fig fruits. As well, it could be noticed that total carbohydrates content was significantly (p≤0.05) varied among olive jam samples. The highest total carbohydrates mean values was observed with SCJ sample, while the lowest total carbohydrates mean values was registered with SFJ sample. Since the carbohydrate content was calculated by difference method, the differences in carbohydrate content may be attributed to the variations in other components like protein, fats, ash and fiber (Rathore *et al.,* 2022). It could be concluded that adding cinnamon enhanced the total carbohydrates content and calorie value, while adding fig fruit reduced total carbohydrates content and calorie value in both SGOP and MGOP jam samples.

Shumaila and Safdar (2009), mentioned that cinnamon contained highest amount of carbohydrate and lowest amount of ash. Lartey *et al.* (2023) revealed that cinnamon bark powder could serve as good carbohydrate source. Nasir *et al.* (2020) recommended fig fruit as good source of energy, fiber, lipid, carbohydrate, protein and minerals. In general, olive jam samples exhibit a good chemical composition property. Decrement in moisture content and increment in total carbohydrates content may be due to the sugar added to the jam or increasing in temperature during jam processing (Choirun *et al.,* 2019).

3.4. Titratable acidity value of olive jam samples

The titratable acidity (TA) is a physicochemical parameter that affect product quality, where it is responsible for a longer shelf-life of the food products as it associates with a certain degree of acidity which prevent microorganism growth in food products (Tifani *et al.*, 2018). Acids present in foods not only improve the palatability of many fruit products but also influence their nutritive value by playing a significant role in the maintenance of acid-base balance in the body (Chalchisa *et al.*, 2022). TA values of olive jam samples were clarified in figure (1). There was a slightly significant (p≤0.05) differences in TA values. The highest mean TA value was observed with MFJ sample (0.7%) followed by CMJ (0.66%). Samples CSJ, MCJ and SCJ were found to have 0.65, 0.64 and 0.62% TA value, whilst the SFJ sample recorded the lowest TA value (0.57%). Wasif *et al.* (2015) found that the titratable acidity value of apple and olive blends jam was 0.67%. Findings were higher than those established by Delgado-Adamez *et al.* (2013) who found out the olive jam had titratable acidity 0.30%. Pandiangan *et al.* (2023), informed that as the cinnamon powder proportion increased in Banten banana jam as the jam acidity decreased and that's due to the alkaline nature of cinnamon powder. Increase in acidity may be due to the formation of acids by degradation of polysaccharides and oxidation of reducing sugar or by break down pectic substance (Hussain, 2008).

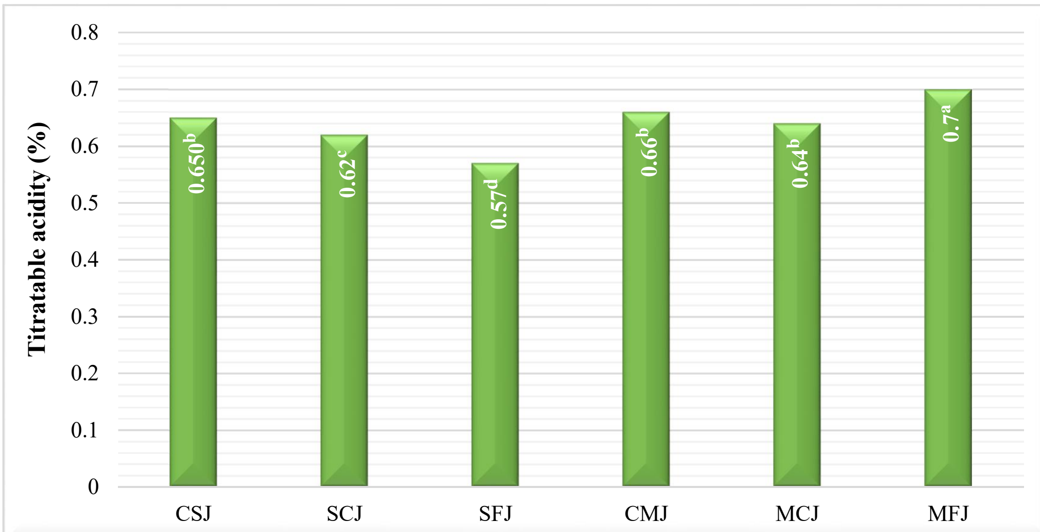

Fig. 1: Titratable acidity value of olive jam samples.

3.5. Total soluble solids of olive jam samples

Measurement of total soluble solids is important to assess the jam quality, it is expressed as degree of brix and considered to be the index of sweetness or sugar content in fruits and other liquid solutions (Sindumathi and Amutha, 2014). Data in figure (2) displayed the total soluble solids (TSS) of all SGOP and MGOP jam samples. The highest mean TSS value was found with the SCJ sample (70 °brix) followed by SFJ sample (69 °brix) then MFJ sample (67 °brix), whilst CSJ, CMJ and MCJ samples observed TSS mean values 66.5, 66 and 65 °brix, respectively. Our results were in accordance with Elsorady and Abdelrasoul, (2012) who confirmed that the total soluble solids of green and black olive jam were 68 and 68.3 °brix, respectively. Also, Wasif *et al.* (2015) declared that the TSS of apple and olive blends jam was ranged from 68.8 to 70.0 °brix. Salama *et al.* (2019) manifest that TSS of gurma melon jam with 30% fig fruits was 69.8 °brix and 68.2 °brix for gurma melon jam contain 0.5% cinnamon powder. Shokry *et al.* (2018) notified that the TSS of pomegranate jam prepared by adding 0.5% cinnamon was 68.3 °brix. Maintaining jam TSS of 68 to 70 °brix support jam taste and protect jam from deterioration, where microorganisms cannot grow at 70% sugar concentration (Taufik and Karim, 1992). The increment of total soluble solid due to the degradation of polysaccharides in the presence of acid, a decrement in moisture content of the jam, increment in jam nutritional composition (Wasif *et al.,* 2015; Benmeziane *et al.,* 2018).

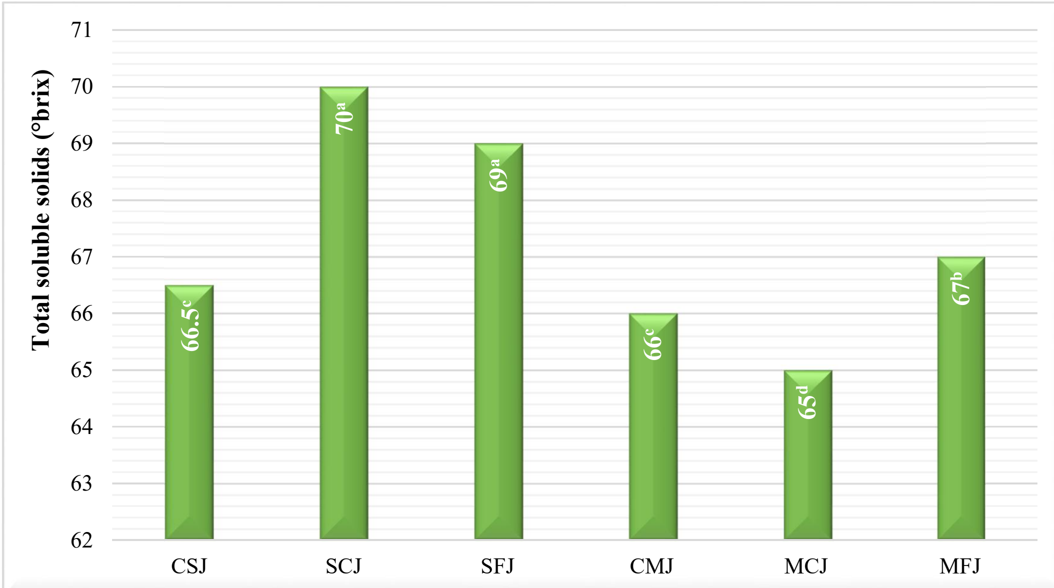

Fig. 2: Total soluble solids of olive jam samples.

3.6. Color of olive jam samples

Color is a critical parameter that any food product quality depends on, in which it affects consumer acceptance. The color of accepted jam samples was performed and results lighted on table (4). Data clarified that, there was a significant ($p \leq 0.05$) difference between L*, a* and b* color parameter for all SGOP and MGOP jam samples. Referring SGOP jam samples, the CSJ sample found to had the maximum mean L* value (34.82) followed by SFJ sample (33.85), whilst the SCJ scored the lowest L* value (29.87). As regarded to b* values, both CSJ and SFJ recorded the nearly mean b* value with no significant differences, however the SCJ recorded the highest b* mean value. The a* mean value was higher with SFJ, SCJ and CSJ with nearly values (5.56, 5.20 and 5.00), respectively. The low L* and b* values mean the darker and more blueness, where the high a* value mean the more redness. Therefore, SCJ become more darker followed by SFJ then CSJ. For the MGOP jam samples, the high mean a* value was observed with the MFJ putted up with MCJ then CMJ sample. The high L* mean value was showed with CMJ follow up MSJ then MFJ sample. That was mean, olive fruit shape, adding both cinnamon and fig fruits affected the olive jam color.

Table 4: Color of olive jam samples.

Olive jam samples	*L**	*a*	*b*
CSJ	34.82^{d} ±0.20	5.00^{b}±0.15	8.56^{e}±0.07
SCJ	29.87^{f} ±0.22	5.20^{b}±0.20	10.04^{d}±0.15
SFJ	33.85^{e} ±0.00	5.56^{b}±0.26	8.46^{e}±0.20
CMJ	36.54^{a} ±0.15	4.21^{c}±0.11	13.81^{a}±0.18
MCJ	35.54^{b} ±0.30	5.54^{b}±0.05	11.94^{c}±0.01
MFJ	35.39^{c} ±0.31	8.28^{a}±0.05	13.28^{b}±0.06

(CSJ) control slice GOP jam, (SCJ) slice GOP jam with o.5% cinnamon, (SFJ) slice GOP jam with fig fruits, (CMJ) control minced GOP jam with fig fruits, (MCJ) minced GOP jam with 0.5% cinnamon, (MFJ) minced GOP jam with fig fruits. Mean value ± Standard deviation of three replicates, means sharing the same small letter in a column are not significantly different at $p \geq 0.05$.

Besides the effect of jam component on jam color, Kammerer *et al.* (2007) notified that Maillard reactions, enzymatic browning ascorbic acid degradation and polymerization of color pigments with other phenolic compound have been affect the final jam color. Same color effect of adding cinnamon was resulted by Shokry *et al.* (2018) when used cinnamon as additive to the pomegranate jam and mentioned that as the concentration of cinnamon increased the pomegranate jam become darker.

Wasif *et al.* (2015) detected that the jam processed by using equal proportion from olive and apple fruits have been stated a good color quality.

3.7. Consistency of olive jam samples

Determination of food product consistency is a predictive information to take guidelines in formulation, processing and product development (Shahnawaz and Shiekh, 2011), thus, consistency of both SGOP and MGOP samples were detected and cleared in figure (3). Consistency of SGOP samples was bring into being lower than consistency of MGOP samples. As for SGOP samples, the consistency value of CSJ sample (48335 cP) was higher than SCJ (48219 cP) and SFJ (48040 cP), respectively. Meanwhile, an inverse trend was exhibit in consistency of MGOP samples, where the highest consistency value was attained with MFJ sample (79948 cP), followed by MSJ sample (79907 cP), while the lowest consistency value was achieved with the CMJ (79653 cP). Which mean that, olive fruit shape, addition of cinnamon and fig fruits have influenced jam consistency.

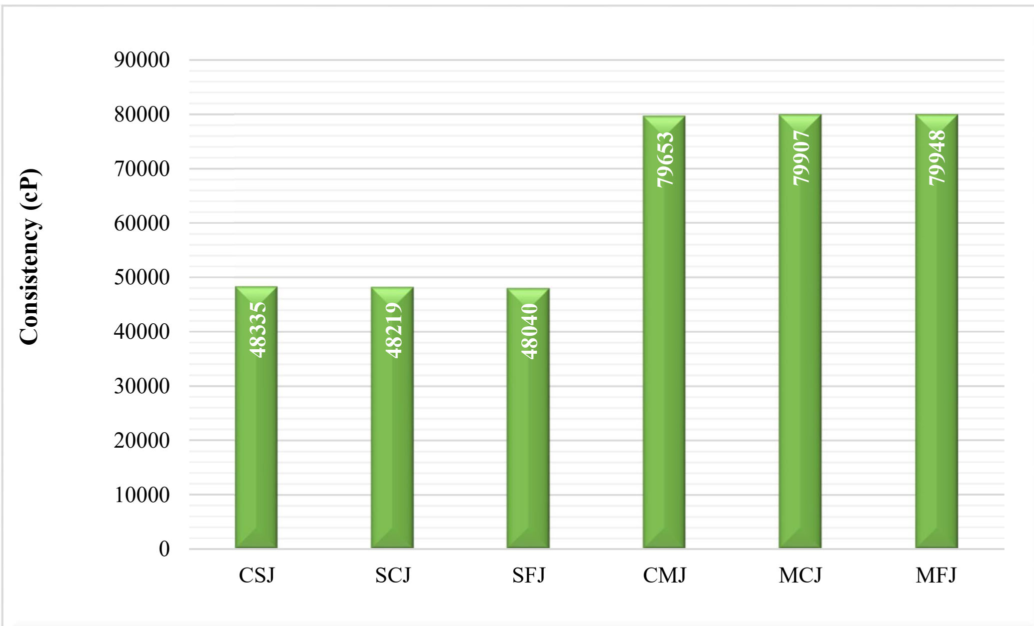

Fig. 3: Consistency of olive jam samples.

Our finds were in full line with those results illustrated by Shokry *et al.* (2018) who informed that adding cinnamon with different proportion affected pomegranate jam, but Salama *et al.* (2019) confirmed that, adding cinnamon with 0.5% did not affect gurma melon jam consistency whilst adding fig fruits with increased consistency with regard to control gurma melon jam.

3.8. Total phenolic content of olive jam samples

Phenolic compounds are important plant constituents with redox properties responsible for antioxidant activity (Soobrattee *et al.*, 2005). Phenolic compounds are a secondary plant metabolite bearing an aromatic ring and having one or more hydroxyl substituents (Wijewardhana *et al.*, 2019). Therefore, total phenolic content of olive jam samples was evaluated. According to data represented in figure (4) it was noticed that, there was a significant ($p \leq 0.05$) effect on total phenolic content of olive jam samples. Total phenolic content of the MCJ was the highest among all olive jam samples with value (86.38 mg GAC/100 g). SFJ, MFJ and SCJ recorded 73.72, 70.32 and 71.17 mg GAC/100g total phenolic content values, whereas CMJ and CSJ found to have the lowest significant ($p \geq 0.05$) total phenolic content value (51.7 and 47.23 mg GAC/100g), respectively. It has been observed that, addition of cinnamon and fig fruits build up the total phenolic content in both SGOP and MGOP jam samples as regard to the control olive jam samples. Chipurura *et al.* (2010) illustrated that all thermal treatment caused reduction in total phenol content. Patras *et al.* (2011) detected a decrement in total phenolic content in jam processing and revealed that decrement as a result of cell disruption structure that occurred during jam processing. El-Sorady and Abdelrasoul, (2012) clarified that there was a decrement in the total phenolic compound in both green and black olive jam with regards to the fresh sample.

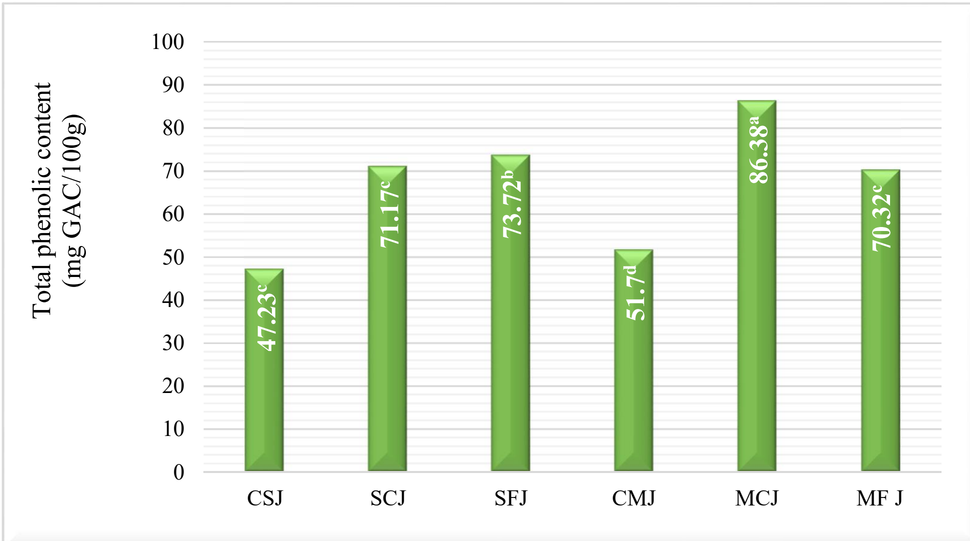

Fig. 4: Total phenolic content of olive jam samples.

Our finding data were in accordance with Shokry *et al.* (2018) who make clear that addition of cinnamon enhanced the total phenolic content of both pomegranate jam. Cinnamon potential health benefits derived from bioactive polyphenols compounds (Vidanagamage *et al.*, 2016). Wijewardhana *et al.*, 2019 cited that cinnamon rich in total phenolic compound. Gupta, (2013) demonstrated that anti-oxidant potential activity of cinnamon was due to the presence of high phenolic contents. Shokry, (2023) identified syringic acid, *o*-cumaric, catechin, ferulic, hydroxybenzoic acid, chlorogenic acid, *p*-cumaric acid, gallic acid and apigenin as a phenolic content in red beetroot jam contained 0.5% cinnamon. Results were not in the same line with Abdel-Malak, *et al.* (2020) who reported that mixed jam fruit contain 50% fig fruits exhibit the lowest content of total phenolic content.

3.9. Antioxidant activity of olive jam samples

Antioxidants play an important role as health protecting factor, it where they reduce the risk for chronic diseases including cancer and heart disease (Shekhar and Anju, 2014). The antioxidant activity of GOP jam samples was determined by using the DPPH (1, 1diphenyl-2-picryl hydroxyl) radical Scavenging assay and results were illustrated in figure (5). Data revealed that, there was a significant ($p \leq 0.05$) difference in DPPH values. The higher mean DPPH value was observed with MCJ sample (21.5%) followed by SFJ sample (20.48%), followed by SCJ and MFJ with DPPH values (16.04 and 14.9 %), respectively. DPPH values related to the total phenolic content detected above. The jam process caused decrement in antioxidant activity of final jam produced (Taha *et al.,* 2011). Wicklund *et al.*, (2005) stated that thermal treatment of jam process negatively affected the antioxidant activity. Abdel-Malak, *et al.*, (2020) displayed a decrement in DPPH activity in mixed jam contained fig fruits. Shokry, (2023) informed that red beetroot jam with 0.5% cinnamon exhibit a good antioxidant potent.

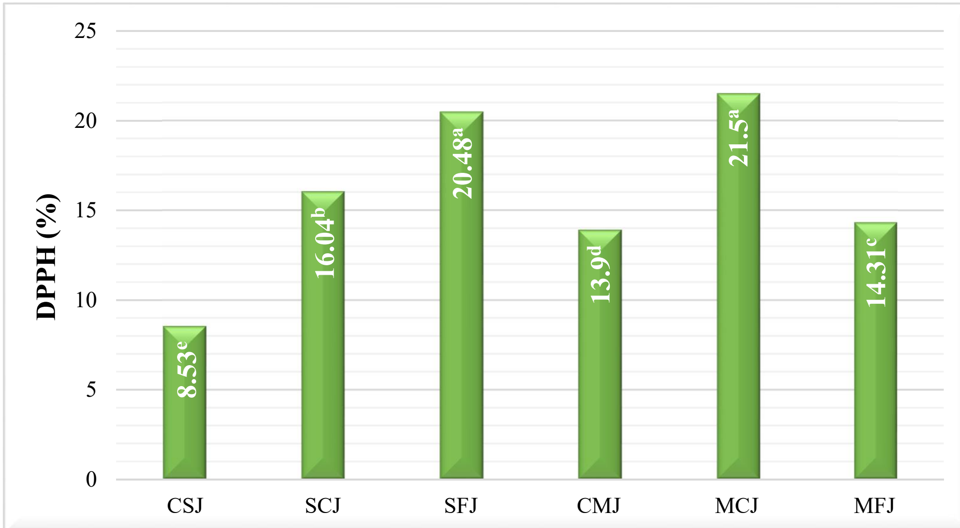

Fig. 4: Antioxidant activity of olive jam samples.

4. Conclusion

Results obtained in the present study clarified that, the more accepted formula of green olive pickled jam according to sensory attributes was the sliced and minced green olive pickle jam samples. Moisture content of all accepted olive jam samples appeared to be in range (28.2% to 33.3%) which was the same as the commercial jam, but it was noticed that the olive fruit shape affected moisture content, where the moisture content of minced control jam sample was lower than the moisture content of sliced control jam sample. The total soluble solids were found to be higher with jam samples contained cinnamon and fig fruits with regard to both sliced and minced control sample. Color of jam samples have been affected by olive fruit shape, adding cinnamon and fig fruits, wherever the SGOP jam samples were darker than the MGOP jam samples. For consistency, it was resulted that the MGOP jam samples stated a higher consistency with concern to SGOP jam samples. Total phenolic content and antioxidant activity found to be enhanced in olive jam samples contained cinnamon powder and fig fruits. Eventually, an olive jam could be successfully developed from the low-quality green olive pickle as an innovative and value-added product.

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