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Improving the Storage Stability of Watermelon (Citrullus lanatus) Jam Incorporating Pectin Extracted from Lemon (Citrus limon L.) Peels

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Abstract

Citrus fruits are a main processed fruit in the world, and hence large quantities of citrus peels from processing industries have become one of the main sources of municipal solid wastes. Although such wastes are a tough environmental, is so citrus peels can be suitably exploited for the production of pectin. This study aimed to use of lemon peels, as a source of pectin and its utilization in the watermelon jam production with different combinations of sugar and pectin levels and assess its quality, stability and suitability during storage. Physico-chemical qualities of jam formulations were assessed using standard AOAC methods. Sensory attributes of colour, taste, texture, aroma and overall acceptability were evaluated by 20 semi-trained panelists using a seven-point hedonic scale. The most preferred jam formulations were selected for storage studies. The watermelon jams were stored at 30±1°C and 70-75% RH for 12 weeks. Physico-chemical analysis during storage of watermelon jams revealed the increasing trend in total sugar, total soluble solids, titratable acidity and moisture. Moreover, the declining trend in pH, and ascorbic acid. The total plate count was examined to the most preferred jam formulations. The different jam formulations were prepared for the dilutions of 100, 10-1, 10-2 with triplicate microbial counts. Based on the physico-chemical quality, sensory analysis and microbiological studies, the watermelon jam with 65 g sugar and 2.8 g pectin, could be prepared and stored for 12 weeks without any significant changes in quality characteristics.

Keywords: Jam • Lemon peels • Physico-chemical properties • Pectin • Sensory assessment

Introduction

Fruits are concentrated sources of natural components. These natural components are plant derived materials performing an important role in maintaining human health, especially in disease prevention, growth and development. Most of the fruits are available only in a particular season and their shelf life is limited, this requires some processing to preserve the nature of the fruits and maintain their quality attributes. Jams were originated as an early effort to preserve the fruit for consumption in the off-seaso. Jam is an intermediate moisture fruit based product prepared from fresh fruits by boiling fruit pulp or fruit extract with sucrose, pectin, acid and other ingredients such as chemical preservatives, coloring and flavoring substances and it is consumed widely in the world. Jam has considerable nutritional value with the desired level of vitamin C, phenolic compounds, antioxidant activities and other nutrients. The essential constituents in the preparation of jam are pectin, sugar and acids in the correct proportion for proper gel formation.

Gelling agents are food additives used to thicken and stabilize various foods, like jellies, desserts and candies. The agents provide the foods with texture through the formation of a gel. Some stabilizers and thickening agents are gelling agents. Typical gelling agents include natural gums, starches, pectin (a polysaccharide obtained from apple or citrus fruits), agar (a polysaccharide obtained from red algae) and gelatin (made by partial hydrolysis of animal collagen). Pectin has been used in jelly manufacture for more than 200 years, but only two traditional sources have been economically important, citrus albedo and apple pomace, despite research into new raw materials.

Citrus fruits, which consist of two parts namely the peels (rind skin) and pulp. These two parts are easily separated from each other with the pulp as the edible parts of the fruit while the peels as a good source of pectin. Pectin can be extracted through various methods. Usually, industrial pectin is extracted in a multiple-stage physico-chemical process characterized by an extraction step with hot dilute mineral acid and recovery through alcohol precipitation (Mollea et al., 2008). Pectin is produced commercially in the form of white to light brown powder, mainly extracted from citrus fruits, and is used in food as a gelling agent particularly in jams and jellies [1].

Watermelon (Citrullus lanatus) considered as the fruit is belonging to the family Cucurbitaceae. Watermelon contains 92% water and 8% sugar [2]. It is rich in lycopene, an antioxidant that gives it its characteristic colour and fat-free. Sugar attracts water, yanking it away from the pectin, which boosts network formation and enhances gelling in regular jams, jellies and preserves. Sugar's water-grabbing activity also helps prevent the growth of molds and bacteria (no available water, no microbes), which gives jam its long-term keeping qualities. Citric acid is important in helping the pectin to set. The optimum pH for persuading jam and jelly to gel is roughly between 2.8 and 3.3. Jams and jellies are sugar containing food products that are possible to getting microbial spoilage immediately after preparation. The molds and bacteria are significant spoilage sources of spoilage of fruit products and their presence in the finished products beyond the permissible level is considered unfit for consumption [3].

The presence of molds in food may reduce food quality and also contamination of food with mycotoxins, which are causing major health problems. Well planned and conducted consumer acceptability tests in the form of appropriate sensory analysis, is an important part of the shelf life evaluation of any product. Accordingly, the objectives of the present study to assess the nutritional qualities, microbial safety and consumer acceptability of watermelon jam using pectin extracted from lemon peels during storage.

Materials and Methods

Extraction of Pectin from Lemon Peels

The lemon peels were collected from juice processing centers and sun dried for 4 days. The dried peels were ground into a fine powder, sieved through a 60 mesh sieve and stored in air tight glass containers at room temperature for further use. The extraction procedure was based on the method given by Georgiev et al. Dried lemon peel powder of 20 g was transferred into a 1000 ml beaker containing 300 ml of 0.05M citric acid (pH 1.5). Thereafter, the mixture was heated while stirring at 80°C water bath for 1 hr. The hot acid extract was filtered through a filter funnel equipped with a two-layer of muslin cloth. To the filtrate, an equal volume of 95% ethanol was added and allowed to precipitate overnight at 4°C. The gelatinous pectin flocculants were skimmed off, washed with ethanol twice to remove impurities and then dried in a vacuum oven at 40°C. The dried pectins powders were dissolved in fresh Milli-Q water for 5 hrs and centrifuged (Beckman Instruments, Inc., Fullerton, CA, USA) at 5,000 rpm for 15 min, at 30°C to remove the insoluble fraction. The supernatants were filtered and vacuum-dried at 40°C for 3 hrs and weighed. The dried pectin was ground into a powder and stored in air tight glass containers at room temperature for further use.

Studies on Development of Watermelon Jam Using Pectin from Lemon peels

A number of preliminary experiments were conducted to find out the proper amount of watermelon pulp, sugar, pectin, citric acid and to develop the recipe for the watermelon jam formation at different combinations of sugar and pectin levels.

Preparation of Watermelon Jam

The watermelon fruits were washed, peeled and the seeds were removed. The fruits were chopped in to small pieces by using knife. Finally, it was blended by using an electric grinder (KENSTAR CLASSIQUE-540) to make watermelon pulp. Weight of watermelon pulp, sugar, citric acid was weighed by using an electric balance (METTER PJ-300). Addition of watermelon pulp and sugar in the ratio of 500:80, 500:75, 500:70, 500:65 and 500:60 respectively into the stainless pan, mixed thoroughly and slowly cooked for 15 minutes with occasional heating until temperature reaches 105°C. Meanwhile pectin (g/100g) and citric acid (g/100 g) were added in the weight ratio of 0:2, 1.8:2, 2.3:2, 2.8:2 and 3.3:2 respectively were added into the pan and cooked by stirring continuously until it reaches the end point, total soluble solid of 68ºBrix. End point was determined by sheet or flake test, then strawberry essence 5 ml (5 ml/100 g) rate was added and mixed thoroughly. Finally, the jam was removed from the fire and cooled for 5 minutes. The plastic cups were sterilized by spraying water at 68-70°C of maintaining the inner pressure at 10-12 kPa to sterilize the inner and outer surface of the cups and allowed to dry. Then jam was filled into plastic cups and sealed with lids.

Experimental Formulations

Treatment 1 (T1): 80 g sugar and no pectin added.

Treatment 2 (T2): 75 g sugar and 1.8 g pectin extracted from lemon peels.

Treatment 3 (T3): 70 g sugar and 2.3 g pectin extracted from lemon peels.

Treatment 4 (T4): 65 g sugar and 2.8 g pectin extracted from lemon peels.

Treatment 5 (T5): 60 g sugar and 3.3 g pectin extracted from lemon peels

Physico-chemical Analysis

Pectin quality characteristics such as colour, solubility in cold and hot water, solubility in cold and hot alkali, pectin yield, ash content, equivalent weight, methoxyl content, and anhydrouronic acid content were analyzed as described by Ranganna. Physico-chemical qualities of the freshly prepared watermelon jam was analyzed using recommended standard methods [4]. The titratable acidity was determined by titrating the jam samples with standard NaOH and the results were expressed as % of citric acid. The pH was measured using Digital pH meter (Model HANNA HI 98130). The Ascorbic acid content was titrimetrically estimated by 2, 6 dichlorophenol indophenol dye method. The moisture content was determined by gravimetric method. The Total Soluble Solids (TSS) was measured by using the hand held refractrometer (Model ATAGO-S-28E) and total sugar of jam samples were determined by Lane-Eyon method. Each parameter was triplicated during analysis.

Microbial Analysis

Potato Dextro Agar (PDA) preparation was carried out without any external contamination. Total plate count was taken as described below.

The peeled potato was cut into small pieces and added in 250 ml of distilled water and boiled. Weighed agar was boiled with 250 ml of distilled water until agar dissolve and placed in a 1000 ml of a flask. Then required amount of sucrose and potato extraction were added into the flask and stirred. Then conical flask containing media was plugged with cotton wool and wrapped aluminum foil. Then it was put into the autoclave at 121oC, 15psi for 20 minutes and the media was allowed to cool. Petri dishes, forceps and needles were kept in the oven at 180oC for one hour and allowed to cool. All the equipments were sterilized by 70% of alcohol. Then it was poured into petri dishes and they were kept in laminar flow until solidify. Different treatment samples were placed in an agar plate. Then petri dishes were covered and labeled. The plates were observed after 4 days for plate count.

Sensory Evaluation

Sensory attributes including colour, taste, texture, aroma and overall acceptability were assessed by 20 semi-trained panelists. The seven-point hedonic scale was used to evaluate the degree of liking (7) and disliking (1) for the preference of the watermelon jam following storage. A structured questionarie was used for the sensory evalution. The test was conducted between 9.00 -11.00 am morning session and 2.00 – 4.00 pm evening session.

Statistical analysis

Each formulation was triplicated in experiments and they were in Complete Randomized Design. Data of the physico-chemical parameters were subjected to analysis of variance (ANOVA) (α = 0.05). Mean separation was undertaken with Duncan’s Multiple Range Test (DMRT) for storage studies. Data related to sensory evaluation was analysed using the Kruskall-Wallis test. Both physico-chemical and organoleptic analysis were undertaken using Statistical Analysis System (SAS) software statistical package.

Results and Discussion

Characterization of Commercial Pectin and Pectin Extracted from Lemon Peels

The extracted pectin and commercial pectin were characterized in terms of pectin colour, solubility in cold and hot water, solubility in cold and hot alkali (NaOH), pectin yield, ash content, methoxyl content, anhydrouronic acid content and gel grade, as these properties determines the suitability of pectin for different purposes. The results are given in the (Table 1).

Table1: Quantitative Characteristics of Pectin.

Quantitative parameters	Lemon peel pectin	Commercial pectin
Pectin yield (%)	20.4	-
Ash content (%)	6.6±0.11	15.2±0.12
Equivalent weight (g/mol)	476±0.12	493±0.11
Methoxyl content (%)	1.56±0.15	3.57±0.13
Anhydrouronic acid (%)	60.95±0.12	68.95±0.10
Gelling grade	113±0.10	150±0.11

The values are means of triplicates ± standard error

Yield of Pectin

Pectin yields varied from 20.4 to 76.0% (dry basis) extracted by using citric acid. The best extraction condition was higher in yield by using citric acid at 80ºC, 60 min at the pH of 1.5. This value remained in close agreement with the results reported by Elizabeth et al. (2014) extracted pectin from sweet lime peel by two different acids (citric and nitric) and at three different temperatures (60, 70 and 80ºC), time (30, 45 and 60 min) and pH (1.5, 2.0 and 2.5).

Yield (%) = (Amount of dry pectin obtained (g))/(Amount of lemon peel powder taken (g))× 100

Ash Content

Ash content of pectin extracted from lemon peel powder using citric acid was found to be 6.6%, which is against 15.2% for commercial pectin. Low ash content is good for gel formation. This parameter as reported in the literature varies in a wide range depending on the method and the nature of the citrus fruits used for extraction. The upper limit of ash content for good-quality pectin is considered to be 10%, from the view point gel-formation (Devi et al., 2014). The ash content indicates the purity of pectin, lower ash content means higher purity. Therefore, with respect to this parameter, the pectin isolated in this study may be considered to be of satisfactorily good quality.

Equivalent Weight

The equivalent weight of pectin extracted from lemon peel powder was found to be 476 g/mol and 493g/mol for commercial pectin and in the range of 476 to 1209 g/mol as reported by Ismail et al. (2012).

Methoxyl Content

The methoxyl content of pectin extracted from lemon peel powder was 1.562%, this result was supported by Azad et al. (2014) which is 3.57% for commercial pectin. Methoxyl content is an important factor in determining the gel formation capacity, controlling the setting time of pectin and the ability of the pectin to form gels. Spreading quality and sugar binding capacity of pectin are increased with increase methoxyl content Azad et al. (2014). Based on methoxyl content value in this study indicates that lemon peel pectin was categorized as low methoxyl pectin (Methoxyl content < 7%).

Anhydrouronic Acid (AUA) Content

The Anhydrouronic Acid (AUA) content of pectin extracted from lemon peel powder was found to be 60.95% which is 68.95% for commercial pectin these results supported by Azad et al. (2014). The AUA indicates the purity of the extracted pectin and its value should not be less than < 65% [5]. The low value of AUA means that the extracted pectin might have a high amount of protein, starch and sugars in the precipitated pectin.

Gelling Grade

Jelly grade is defined as the number of grams of sugar with which one gram of pectin will form a 65% soluble solids gel of specified strength under suitable acid conditions. The gelling grade of pectin extracted from lemon peel was 113-grade, and the commercial pectin is 150-grade pectin, meaning that with water, sugar to give 65% solids, and acid to give the optimum pH.

Physico-chemical parameters were analyzed for the watermelon pulp initially to develop the standard recipes of watermelon jam. The physico-chemical parameters of watermelon pulp (Citrullus lanatus) and lemon peels (Table 2).

Table2: Physico-Chemical Parameters of Watermelon Pulp and Lemon Peels.

Quality Characteristics	Watermelon pulp	Lemon Peel extract
Titratable Acidity (as % citric acid)	0.19±0.12	0.16±0.12
pH	6.13±0.012	1.72±0.01
Total soluble Solids (°Brix)	13.04±0.01	6.80±0.01
Vitamin C content (mg/ 100ml)	5.81±0.01	0.24±0.01
Total sugar (%)	5.25±0.01	2.37±0.01

The values are means of triplicates ± standard error

Changes in Quality Characteristics during Storage

The formulations with high sensory scores in organoleptic evaluation such as T1, T3, T4, T5 were selected for storage studies and they were kept under ambient conditions for 12 weeks. The physico-chemical parameters such as titrable acidity, pH, ascorbic acid, moisture, total soluble solids and total sugar amount were assessed at 2 week intervals.

The results of sensory parameters such as colour, taste, texture, aroma, and overall acceptability were determined at the end of 12 weeks storage

Physico-chemical Analysis of Jam Formulations during Storage

Titratable Acidity

Titrable acidity is an important quality factor related to flavour. If the acid level is too low, the product may be bland and unappealing. Acidity is the direct proportional measure of shelf- life of the product against microorganism growth.

Figure 1 shows the changes in titratable acidity of the watermelon jam during storage.

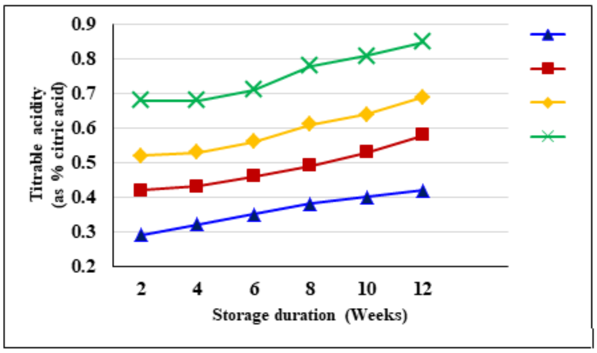

Figure1: Changes in Titrable Acidity in Watermelon Jam during Storage.

The values are means of triplicates ± standard error(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

The overall result showed that, the acidity of watermelon jam significantly ($p<0.05$) increased through the storage period reaching a maximum value of 0.89% was observed in jam with 3.3g pectin after 12 weeks.

The minimum value of 0.29% was observed in jam with no pectin added after two weeks.

This might result from formation of carboxylic acids from alcohol which was produced from sugar and may be due to the addition of citric acid into the watermelon jam.

Total pectic substances have been reported to increase the acidity in fruit products (Conn and Stumf, 1976), hence degradation of pectin substances of pulp into soluble solids might have contributed to an increase the acidity in products.

pH

The results indicated that the pH of watermelon jam decreased with increasing duration of storage in all the formulation. There was a significant (5%) decrease in pH during storage period at ambient temperature (30°C).

It was observed that the maximum pH (3.94) in the jam with no added pectin formulation in 2nd week and the least pH (3.31) was observed in T5 (3.3g pectin) at the end of storage. The pH of preserved products plays a role as a preservative (Ahmed et al., 2016).

The result pertaining to the response of storage duration and different treatments of watermelon jam on pH are present in (Table 3).

Table3: Changes in pH of Watermelon Jam during Storage

Storage duration (Weeks)	pH value			
	T1	T3	T4	T5
2	3.94±0.01a	3.80±0.02b	3.52±0.01c	3.30±0.01d
4	3.93±0.02b	3.78±0.03b	3.51±0.02c	3.29±0.02a
6	3.92±0.02a	3.76±0.01b	3.50±0.02a	3.26±0.01c
8	3.91±0.05d	3.74±0.02a	3.49±0.01a	3.24.±0.01d
10	3.89±0.02e	3.72±0.02b	3.43±0.01b	3.32±0.01d
12	3.80±0.01a	3.71±0.01b	3.41±0.01c	3.31±0.04e

The values are means of replicates ± standard error

The means with same letters in the same column are not significantly different at p<0.05

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

The reason for the decrease in pH might be due to the formation of acids from added sugar during the storage.

The results are in accordance with the findings of Hussain and Shakir (2010), who investigated that the pH of watermelon lemon jam samples showed decreasing trends during time intervals during storage.

Ascorbic acid Content

The ascorbic acid content of the watermelon jam decreased with the increase of storage period.

According to DMRT, the ascorbic acid content had significant (p<0.05) decreasing trend to the storage in all formulations.

The reason for ascorbic acid reduction during storage probably due to oxidation of ascorbic acid into dehydro-ascorbic acid by trapped oxygen in the containers and also due to its role as a substrate in non-enzymatic browning reactions.

That oxidation due to temperature and greater catalytic activity of fructose in the catabolization of vitamin C (Table: 4).

Table 4: Changes in Ascorbic acid Content of Watermelon Jam during Storage

Ascorbic acid Content (mg/100ml)				
Storage duration (Weeks)	T1	T3	T4	T5
2	4.64±0.02a	4.71±0.02b	4.92±0.01c	5.29±0.01a
4	4.62±0.02b	4.68±0.03b	4.82±0.02c	5.20±0.02b
6	4.61±0.02a	4.62±0.01b	4.80±0.02a	5.16±0.01c
8	4.60±0.03d	4.53±0.02a	4.60±0.01a	5.12±0.01d
10	4.50±0.02e	4.23±0.02b	4.58±0.01b	5.10±0.01d
12	4.44±0.01a	4.21±0.01b	4.51±0.01c	5.06±0.04e

The values are means of replicates ± standard error

The means with same letters in the same column are not significantly different at p<0.05.

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

A substantial reduction in ascorbic acid content of the sample during storage could be due to both oxidative and non-oxidative changes as described by Eskin and Land . The highest mean value 5.29 mg/100 ml for ascorbic acid observed in T5 (Jam with 3.3g pectin) in 2nd week and least mean value 4.21 mg/100 ml was observed in T3 in 12th weeks.

Moisture Content

Moisture is an index of the shelf life of any food.

Moisture content of less than 10% is responsible for the state of non-deterioration in dehydrated food. In all treatments, moisture content significantly (p<0.05) increased throughout the storage period reaching a maximum value of 66.4% was observed in jam with 60g sugar at the end of 12 weeks storage period shown in Figure 2.

Minimum moisture content observed in T5 value is 53.9%.

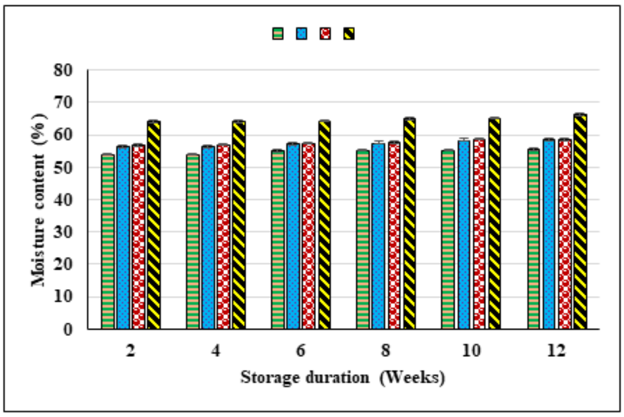

Figure 2: Changes in Moisture Content of Watermelon Jam during Storage.

The values are means of replicates ± standard error

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

The moisture content gradually increased during storage may be due to the hydrolysis of sugar into alcohol, carbon dioxide and water.

Our findings are in agreement with the results reported by Yousif and Alghamdi in date jelly.

Total Soluble Solids (TSS)

The results observed during the storage period of watermelon jam formulations . According to DMRT, there were significantly (p<0.05) increasing in Total Soluble Solids among treatments.

This might be due to the hydrolysis of polysaccharides into simple sugars during storage and also due to conversion of some of the insoluble fraction into soluble fraction (Table 5).

Table5: Changes in Total Soluble Solids (°Brix) of Watermelon Jam during Stora

Total Soluble Solids (°Brix)				
Storage duration (Weeks)	T1	T3	T4	T5
2	67.81±0.01a	67.80±0.02b	66.54±0.01c	66.10±0.01a
4	67.85±0.02b	67.81±0.03b	66.57±0.02c	66.12±0.02b
6	67.89±0.02a	67.83±0.01b	66.59±0.02a	66.14±0.01c

8	68.10±0.05d	67.85±0.02a	66.62±0.01a	66.18±0.01d
10	68.15±0.02e	67.86±0.02b	66.65±0.01b	66.23±0.01d
12	68.17±0.01a	67.87±0.01b	66.67±0.01c	66.26±0.04e

The values are means of replicates ± standard error

The means with same letters in the same column are not significantly different at p<0.05.

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

These findings were in agreement reported by Khan et al. With the increase in TSS of pear apple jam during storage, similar findings were in agreement reported by Shakir et al. With the increase in TSS of watermelon and lemon jam during storage. Maximum mean value (68.17°Brix) for TSS was observed in formulation which had 80g of sugar in 12th week of storage period. The minimum mean value of (66.10°Brix) was observed in formulation which had 60g of sugar in 2nd week of storage period.

Total Sugar

As shown in Figure 3 the Total sugar content of the watermelon jam increased significantly (p<0.05) throughout the storage. Total sugar in all treatments had the increasing trend with the storage period. The total sugar content in watermelon jam increased apparently during storage, which might be due to the hydrolysis of polysaccharides like pectin and starch and inversion of non-reducing sugars into reducing sugars could be one the reasons for increase in the sugar content. The highest mean value (89.2%) was recorded by T1 (Jam formulation with 80g sugar) in 12thweek and least mean value (50.2%) was recorded T5 (Jam formulation with 60g sugar) in 2nd week.

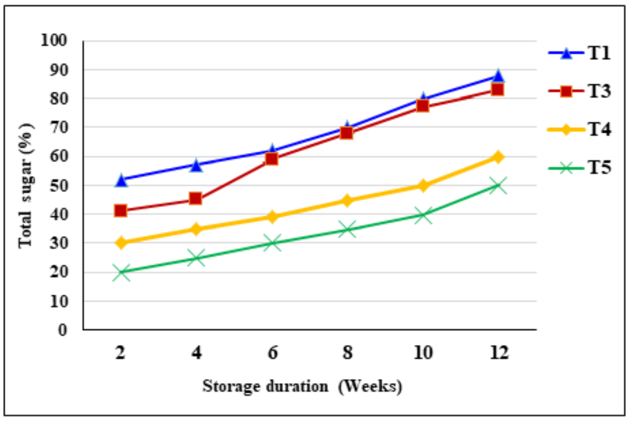

Figure3: Changes in Total Sugar Content of Watermelon Jam during Storage.

The values are means of triplicates ± standard error

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

The highest total sugar content was found in jam is explained by increased reducing sugar solubility, resulting from sucrose inversion. The jam formulation with 80g of sugar (T1) had a highest mean value (86%) for reducing sugar after 12 weeks. The least mean value (10.23) was observed from (T5) in 2nd week.

Microbial Analysis

The total plate count was done to the prepared watermelon jam The different jam formulations were used to prepare the dilutions of 100, 10-1, 10-2 and microbial counts were triplicated.

Sensory Analysis of Watermelon Jam Following at the End of Storage

In this investigation, organoleptic scores were decreased gradually with the increase in storage period at room temperature 30±1. The sensory scores with respect to colour of all formulations were slightly decreased after 12 weeks of storage (Table 6). According to the mean value of sensory scores the highest mean value for colour observed in formulation T4 (2.8g pectin and 65g sugar). These jam formulations had natural colour pigments. In storage it could be attributed to enzymatic or non-enzymatic browning (Maillard reactions). Table 6 shows a general decrease in taste score of watermelon jam formulations. The watermelon formulations containing (2.8g pectin and 65g sugar) had the highest mean score 4.72 for taste and formulation with (80g sugar and no pectin added) had the least mean value score 3.49 for taste score. This might also be attributed to the oxidation of ascorbic acid into dehydroascorbic acid and tannins to gallic acid, increase the acidity and it caused for the sourness of prepared jam (Table 6).

Table6: Sensory Analysis of Watermelon Jam during Storage

Treatments	Colour	Taste	Texture	Aroma	Overall acceptability
T1	3.29±0.001 a	3.49±0.001 a	4.52±0.001 a	3.42±0.001 a	3.68±0.001 a
T3	4.32±0.001 c	4.62±0.002 c	4.72±0.001 c	3.56±0.001 c	5.23±0.001 c
T4	5.49±0.003 d	5.49±0.003 d	5.70±0.003 d	4.84±0.003 d	6.06±0.003 d
T5	5.27±0.001 a	4.56±0.001 a	5.74±0.001 a	4.20±0.001 a	5.84±0.001 a

The values are means of 25 replicates ± standard error

The means with the same letters in same column are not significantly different from each other at 5%.

(T1- 80g sugar and no pectin added; T3- 70g sugar and 2.3g pectin extracted from lemon peels; T4- 65g sugar and 2.8g pectin extracted from lemon peels; T5- 60g pectin and 3.3g pectin extracted from lemon peels).

Table 6 shows a general decrease in texture score of watermelon jam formulations during storage. The watermelon formulations containing (3.3g pectin and 60g sugar) had the highest mean value score 5.01 and formulation containing (80g sugar and no pectin added) had the least mean value score 4.52 for texure, the possible reason for the decrease in texture score might be due to conversion of pectin into pectic acids and further into sugars and galacturonic acids. According to the results obtained for aroma shown in Table 6, the mean scores for aroma revealed that there were significant reductions in the aroma of watermelon jam after the storage period of 12 weeks.

The decrease in aroma during storage could possibly due to loss of volatile aromatic compounds in the watermelon jam. Table 6 shows a general decreasing trend in overall acceptability. The mean scores for overall acceptability revealed that there were significant reductions in overall acceptability of watermelon jam after storage period of 12 weeks. Decrease in overall acceptability might be due to loss of appearance, flavor uniformity in food products during storage.

Conclusion

This study revealed that lemon peel is a good source of pectin it gives a significant amount of pectin where it can be considered in commercial production, the low gel strength of the jam can be improved by the addition of lemon peel pectin during processing to attain the commercially acceptable gel strength. Based on the results of the present study, it was concluded that the watermelon jam prepared with 65g sugar and 2.8g pectin is the best formulation for commercial preparation, and could be stored at 30±1 and 70-75% RH for 12 weeks without any significant changes in the quality characteristics and consumer acceptability.

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