Effect of Minimal Processing Versus Thermal Processing on the Quality Characteristics of Grapefruit Juice

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ABSTRACT

This study was carried out to evaluate the effect of using ultraviolet (UV), ultrasound (UV) with orange peel extract (OPE) combined treatments as novel minimal processing techniques vs. thermal processing on the physiochemical, microbiological and sensorial characteristics of grapefruit juice. Grapefruit juice samples were untreated (control), thermally processed (at 90°C for 5 min) and minimally processed at four combinations (sonicated by using 35 kHz frequency at 25°C for 15 and 30 min. / UV treated by using UV dose 3.525 J/m² at 25°C for 15 and 30 min. / 250 µl orange peel extract). The results showed that thermal and minimal processing of grapefruit juice did not affect its physiochemical characteristics. The degradation of ascorbic acid for minimally processed juice was lower (11.11- 20.5%) than that occurred by thermal processing (63.8%). The extractability of carotenoids and polyphenols of minimally processed juice sample was significantly increased ($p < 0.05$) as compared to control and thermal processed juice samples which contain the lowest carotenoid and polyphenol contents, this was reflected in recording the highest antioxidant capacity for minimally processed samples. Thermal and minimal processing exhibited noticeable reduction in microbial load as compared to control. Also, the minimally processed samples had lower sensory scores than control but higher than that of thermally processed sample. Results obtained support the use of minimal processing technique to preserve grapefruit juice with keeping their quality characteristics.

Key words: Thermal processing, ultraviolet, ultrasound, orange peel extract, minimal processing, grapefruit juice.

INTRODUCTION

Grapefruit juice (*Citrus paradisi*) is produced all over the world, because of its health benefits and favourite taste. In addition to its high content of ascorbic acid, which inhibit oxidative reactions in vivo. Unfortunately, grapefruit juice encourages the growth of microorganisms, such as mould and yeast, which may cause spoilage of juice even at cold storage because of its nutrients content beside its low pH value (2.9–3.3) (Chia *et al.*, 2012). So it is necessary to preserve treatment for preventing spoilage (Van Impe *et al.*, 2018). Thermal processing is an effective preservation treatment as it has destructive effect on both enzymes and microorganisms, but it can detrimentally affect nutritive, sensory and functional characteristics of juices (Barba *et al.*, 2012). Also, consumer's concern for healthy foods (with fresh quality characteristics), forced food processors to use minimally processing techniques which can inactivate microorganisms and certain enzymes of interest to give foods sufficient shelf life during storage and distribution without affecting the nutritional and sensory characteristics as occurred by heat treatment (Siddiqui and Rahman, 2014 and Aadil *et al.*, 2018).

Minimal processing is based on hurdle technologies, especially non-thermal hurdles such as additives, modified-atmosphere packaging, antioxidants, antimicrobials, ultraviolet radiation, sonication, and high hydrostatic pressure, etc. (Bansal *et al.*, 2015 and Alzamora *et al.*, 2016).

Ultraviolet (UV) radiation is used to protect juices from spoilage. The used wavelength is between 200–280 nm, inhabit microbes by blocking DNA transcription (Franz *et al.*, 2009 and Caminiti *et al.*, 2012). Ultraviolet light when used in preservation fruit juices reduce the harmful resistant microorganism by a 5 log reduction (Koutchma, 2009). UV radiation is a safe method for preserving juices (Alabdali *et al.*, 2020).

Similarly, ultrasound (US) preserves foods such as fruit juices by inhibiting microorganisms and enzymes, which cause spoilage changes (Fonteles *et al.*, 2012). Ultrasound induces cavitation, form gas bubbles in the juice, which explode producing stark shock waves which forming free radicals across the cell membrane, resulting in microbial inhibition (Su *et al.,* 2013).

Citrus peel extracts are containing essential oils, which inhibit the growth of microbes (Chun-Lin *et al.,* 2013). So, Khandpur and Gogate (2016) invented a novel approach by using the recovered active ingredients from citrus peel wastes in combination with other treatments for juice preservation. So, This Rresearch aimed to evaluate the effect of combination ultraviolet, ultrasound and orange peel extract as minimal processing techniques for preserving grapefruit juice comparing traditional thermal processing.

MATERIALS AND METHODS

Materials: -

Grape fruit samples:

Grapefruit (*Citrus X paradisi*) star ruby cultivar was purchased from Daltex agriculture, El Gharbia, Egypt and immediately transported to the laboratory for processing in October 2020.

Essential oil of orange peel extract:

Essential oil of Baladi orange was acquired from El-Marwa food industries, Juhayna group, (6th of October City, Egypt).

Chemicals:

All chemicals and reagents used in analytical methods were analytical grade, produced by Sigma-Aldrich, CO. (St. Louis, MN, USA) were purchased from El-Gamhouria Trading for Chemicals and Drugs Company, Egypt.

Microorganisms' strains:

Four bacterial strains representing gram-negative (*Escherichia coli* and *Bacilus subtilus*), gram positive bacteria (*Enterobacter* and *Pseudomonas sp*) and fungi strains (*Aspergillus niger*) were obtained from Chemistry of Natural and Microbial product Department, National Research Center, Giza, Egypt. These microorganisms were checked for their purity and identity and finally recultivated to obtain active cultures.

Methods:

Technological Methods:

Preparation of grapefruit juice:

The fruits of grapefruit were washed with tap water, sorted to discard the unripe or spoiled ones, peeled, cut with sharp knife and the juice was extracted by using a domestic juice extractor (Braun model NO: B-2007, 1.750-liter blender chopper safety switch power: 220-240V, 50/60 Hertz, 450 W, Multiple speeds Germany). Grapefruit juice was subjected to filtration through sterilized folded muslin cloth to obtain pure juice.

Processing treatments of grapefruit juice:

The treatments of grapefruit juice; control (untreated), thermal processed and minimal processed are shown in Table (1) the processing was carried out as follows:

Thermal processing (TP) of grapefruit juice:

Thermal processing was applied by using indirect heating of grapefruit juice in a double jacket suit at (90^{o}C/5min.), then packed in clean sterile bottles and cooled to room temperature according to Sorrivas *et al.* (2006).

Minimal processing of grapefruit juice:

grapefruit juice was firstly sonicated, then treated with UV radiation and finally orangepeel essential oil crude extract (OPE) was added. The processing variables were chosen according to preliminary experiment using the hurdles individually to determine the optimum exposing time / concentration of a hurdle. Minimal processing treatments were achieved as follows:

Sonication treatment:

The fresh cleared grapefruit juice (50 mL batch) was sonicated at 35 kHz frequency for 15 or 30 min. under dark condition, using an ultrasonic cleaning bath (Germany ultrasonic bath D- 78224 singen / Htw, HF- frequency 35 kHz) as carried out by Santhirasegaram *et al.* (2013). The actual power dissipated in the ultrasonic bath was 68–75 W, and the acoustic energy density was 1.36–1.44 W/cm^3, which was determined by calorimetric method (Gogate *et al*., 2011).

UV treatment:

Grapefruit juice samples were exposed to UV light in batch system for 15 or 30 min. by using a germicidal fluorescent UV lamp (30 W, 89.3 cm length, 2.5 cm diameter, Holland) in a laminar flow cabinet according to a modified method of Santhirasegaram *et al.* (2014) with using a glass rectangle (86.44 cm long, 18 cm wide) instead of petri dishes with keeping the same juice height (0.26 mm), with batch volume (405 mL).The mean of the used UV radiation dose is 3.525 J/m^2 as determined by Keyser *et al.* (2008).

Orange peel extract (OPE) addition:

250 μl/100 ml (OPE) were added to the US/ UV treated juice, this concentration is determined as the most inhibiting concentration of microbes.

Packaging of grapefruits juice samples:

Untreated, thermally processed and minimally processed juice samples were packaged in sterilized bottles and kept at refrigerated temperature (4°C ±1) until analyzed for physiochemical, microbial and sensorial quality according to Guo *et al*. (2014).

Physiochemical analyses:

Physiochemical parameters:

pH value, titratable acidity (T.A) and total soluble solids (T.S.S) were determined according to AOAC (2016).

Non-enzymatic browning:

Non-enzymatic browning of undiluted samples was determined according to Ranganna, (1977).

Determination of vitamin C (L-Ascorbic acid):

Ascorbic acid content was estimated in grapefruit juice samples using 2, 6 dichlorophenol-indophenols by a titratable method according to AOAC. (2016) and the result was expressed as mg ascorbic acid / 100 ml sample.

Determination of Total Carotenoids:

Total carotenoids were extracted and determined according to Asker and Treptow (1993)

Determination of total phenolic compounds (TPC):

Total phenolic compounds were determined according to Jaramillo-Flores *et al.* (2003).

Determination of antioxidant activity:

Antioxidant activities were determined by using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method as described by Lee *et al.* (2007).

Colour determination:

The colour of juice samples was measured using Hunter Lab colour system (Hunter, Lab Scan XE - Reston VA, USA). The instrument was calibrated using a white tile (L^*= 92.46; a^*= - 0.86; b^*= -0.16). Colour values were expressed as L^* (lightness or brightness/ darkness), a^* (redness/greenness) and b^* (yellowness / blueness) according to Feng *et al.* (2013).

Microbiological analyses:

Determination antimicrobial activity of orange peel extract (OPE):

Antimicrobial activity against different microbes such as *E. coli, Enterobacter, Pseudomonas aeruginosa, Bacillus subtillis* and *Aspergillus niger* was determined according to Mathur *et al.* (2011) by using the following concentrations of orange peel extract; 100,150,200 and 250 μl.

Total bacterial, Moulds and yeast counts:

Total bacterial, Moulds and yeasts were carried out by procedures of Hatcher *et al.* (1992)

Statistical analysis

The data were statistically analyzed by using the Statistical Package for Social Science (SPSS) computer program software; (version 20.0 produced by IBM Software, Inc. Chicago, USA) of completely randomized design as described by Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

Antioxidants content and antioxidant activity of orange peel extract (OPE):

Table (2) shows the orange peel extract content of antioxidants and its antioxidant activity, the results show that orange peel extract contains 55.47 mg/100 ml, 16.10 mg/ml, 163. 25 mg/ml of ascorbic acid, total carotenoids and total phenols respectively, while its antioxidant activity is 91.48%; These results are supported by Hegazy and Ibrahium (2012) and Montero-calderon *et al.* (2019) since they found that orange peel extract has a high antioxidant activity and contains many active compounds.

Antimicrobial activity of orange peel extract (OPE):

Table (3) shows the antimicrobial activity of orange peel extract (OPE). The results exhibit that orange peel extract has antimicrobial effect on all tested microbes. The antimicrobial activity is increased as the level of orange peel extract is increased, since the highest antimicrobial against tested microbial strains was observed with the highest concentration (250 μl). The same trend was also noticed by both Khandpur and Gogate (2016) and Shehata *et al.* (2020) since they reported that orange peel extract showed antimicrobial effect on the different microbes.

Effect of minimally processing treatments vs. thermal processing on physicochemical characteristics of grapefruit juice:

The physicochemical characteristics of juices have an important role in their quality, palatability and consumer acceptability, as well as they are related to the healthy safe quality criteria. Table (4) shows the physiochemical characteristics of thermal and minimally processed grapefruit juice samples. The results show that no significant changes between the control, thermal and minimal treatments in pH values (3.14 to 3.20), TA (2.14 to 2.19%) of and TSS (9.34 to 9.37^{0}Brix). These results agree with Kaya *et al.* (2015) in a study on lemon-melon juice blends treated with UV and Yuk *et al.* (2014) for thermally treated orange juice.

Table (4) shows the non-enzymatic browning index (NEBI) which indicates darkening of grapefruit juice as a result of Maillard reaction, which subsequently causing colour and nutrients deterioration (Caminiti *et al.,* 2011). Table (4) indicates a significant increment ($p< 0.05$) in the NEBI of thermally processed juice (0.396) as compared to the control (untreated) (0.243). It is clearl that thermal processing of juice enhances Maillard reaction, which consequently darkens the colour of the juice. Similarly, Bull *et al. (*2004) observed a significant browning in the thermally treated orange juice.

On the other hand, minimally processed juice samples showed a slight increase in NEBI when compared to thermal processing sample (0.396). From the data UV15/US15/OPE and UV15/US30/OPE showed a slight increase in NEBI contents; 0.251 and 0.277 respectively, while juice samples, UV30/US15/OPE and UV30/US30/OPE exhibit high NEBI contents, 0.282 and 0.318 when compared to the control sample (0.243). This agrees with Caminiti *et al.* (2011) who stated that non–thermal processing methods, protect the colour of apple and cranberry juice blends from darkening.

Effect of minimally processing treatments vs. thermal processing on the content of antioxidants and antioxidant activity of grape fruit juice:

Table (5) shows the changes occurred in ascorbic acid content as a function of thermal and minimally processing of grapefruit juice. The results indicate that thermal or minimally processing significantly decreased ($p< 0.05$) ascorbic acid content of grapefruit juice. The highest reduction of ascorbic acid content was noticed for thermally processed juice sample (63.8%) as compared to the control sample, which is due to the oxidation of ascorbic, because of its heat-sensitivity in presence of oxygen (Oms-Oliu *et al.,* 2012). So, it is the most labile vitamin and considered as an appropriate indicator for monitoring quality changes during food processing and storage (El-Damaty *et al.,* 2018). These results are similar to that obtained by Goh *et al.* (2012) who recorded that thermally processing of pineapple juice reduces ascorbic acid content as compared to control and UV treated ones. The lowest degradation of ascorbic acid (11.11%) was observed for UV15/US15/OPE sample which has ascorbic acid content, 33.20 mg/100 ml, while the highest degradation (20.50%) was observed for UV30/US30/OPE sample. The degradation of ascorbic acid occurs mainly by enzymes (Oms-Oliu *et al.,* 2012), formation of hydroxyl radicals by UV radiation and also bubble explosion by sonication (Bhat *et al.,* 2011a).

Regarding carotenoids content of thermal and minimally processed juice samples. Table (5) shows that thermal processing significantly decreases ($p < 0.05$) in carotenoid content (58.12 mg/100 ml) as compared to the control sample (98.11mg/100 ml). The decreasing of total carotenoid content may be due to that high temperature promotes isomerization of carotenoids, oxidation, and forming of epoxides (Rodríguez-Amaya, 1997). These results are on the line with that obtained by Goh *et al.* (2012) who reported a significant degradation of carotenoids in thermally processed pineapple juices.

In contrast, minimally processing increases the carotenoid content. The UV15/US15/OPE sample showed the highest increment ratio in carotenoids (13.9%). These phenomena were due to the sonochemical and UV photochemical reaction which improve the extraction of free carotenoids (Demirdoven and Baysal, 2008 and Oms-Oliu *et al.,* 2012).

Also, Table (5) shows the effect of thermal and minimal processing on total phenolic contents of grapefruit juice. The results show that the thermal processing results in a significant reduction in phenolic compounds content (37%), which on the line with the results that obtained by Santhirasegaram *et al.* (2014) who reported that thermal processing of mango juice caused a significant decrease of polyphenols content. Similarly, Bhat *et al.* (2011b) found that thermal pasteurization caused a significant reduction (38%) in total polyphenol content in star fruit juice.

In contrary, minimally processing caused an increment in polyphenols content ranged from 24 to 38.3% as compared to the control. The highest polyphenols content (102.94 mg GAE/100 ml) was recorded for UV15/US30/OPE sample. These results are in agreement with Abid *et al.* (2014) who reported that the extractability of phenolic compounds significantly increased in sonicated apple juice. Also, Ashokkumar *et al. (*2008) reported that formation of free radicals by cavitation improves the extractability polyphenols. Also, UV and ultrasound destroyed polyphenol oxidase enzyme, which protects phenolic compounds (Oms-Oliu *et al.,* 2012). The same trend was noticed in starfruit juice after treated with UV by Bhat *et al.* (2011b).

Also, Table (5) shows the changes in the antioxidant activity measured by DPPH. The results indicated that significant reduction was observed in DPPH for thermally processed grapefruit sample (47.59 %) as compared to the control sample (68.38 %). These results agree with Santhirasegaram *et al.* (2013) who observed that heat processing of mango juice is significantly reduce the antioxidant activity. On other hand, all minimally processed grapefruit samples showed significant increases in DPPH % as compared to the control. The highest DPPH (72.63 %) was recorded for UV15/US15/OPE sample.

Effect of minimal processing treatments vs. thermal processing on colour of grapefruit juice:

Table (6) shows the effect of thermal and minimal processing on the colour of grapefruit juice. The results show that there are significant differences ($p < 0.05$) in colour of juice samples since decreases in lightness (L^*) and in redness (a^*) and yellowness (b^*) were observed in all treatments as compared to the control. The decrease in L^*values could be attributed to the brightening effect of juice due to cavitation collapse of bubbles during sonication and UV photo-degradation of coloured compounds (Bhat *et al.,* 2011b and Tiwari *et al.,* 2008). The results align with NEBI results, the decrease in (b^* and L^*) values explain the darkening of juice colour. The decrease in b^* value may be due to act of isomerizes on carotenoids, as mentioned by Rattanathanalerk *et al.* (2005).

Minimally processed samples showed lower variation as compared to the control sample. However, an increase in ΔE is observed as the ultrasonic treatment time increased, regardless of the UV treatment. Thus, sonication could be responsible for juice colour degradation Cheng *et al*. (2007).

Effect of minimal processing treatments vs. thermal processing on microbial inactivation of grapefruit juice:

Table (7) shows the effect of minimal and thermal processing on the growth of microbes in grapefruit juice. The results indicate that thermal processing was completely inhibiting coliform, total bacterial, yeast and mould in grapefruit juice. This is aligned with the finding of Noci *et al.* (2008) who reported that microbial count is reduced to below detection limit (<1 log CFU/mL) in thermally processed apple juice. The results also show that minimally processed grapefruit juice sample was free from coliform.

Regarding bacterial, mould and yeast counts, the thermal and minimal processing treatments except UV15/US15/OPE caused complete inhibition the microbial growth. This could be explained by the effect of cavitation bubbles which generates high- pressure and temperature, resulting in destroying of the microbial cells (Zupanc *et al.,* 2019). Additionally, absorption of UV ray causes formation of cross-links between pyrimidine bases on the same DNA strand, which inhibit microbes (Pala and Toklucu, 2013 and Walkling-Ribeiro *et al.,* 2008).

Table (8) shows means of sensory characteristics evaluation of thermal and minimally processed grapefruit juice samples as compared to fresh untreated control sample. The control sample was recorded the highest scores ($p < 0.05$) for all sensory characteristics, while thermally processed samples showed the lowest scores which indicates that thermal processing adversely affect the sensorial characteristics of grapefruit juice, which is supported by results of Sentandreu *et al.* (2005) who observed that fresh taste of thermally processed citrus juices is decreased as compared to control. Also, Pala and Toklucu (2013) reported significant lower scores for sensory attributes (flavour and aroma) for thermally processed orange juice.

On the other hand, minimally processed grapefruit juice samples showed lower variation from control in all sensory characteristics, which is increased as the time of treatment is increased. These results are on the line with that obtained by Caminiti *et al.* (2011) who reported significant lower scores for odour and flavour of ultrasonic-treated apple and cranberry juice blends.

CONCLUSION

Finally, minimal processing using UV treatment, sonication and orange peel extract in combination can be used to preserve grapefruit juice with keeping the physicochemical, microbiological and sensorial quality characteristics.

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Table 1: Processing treatments of grapefruit juice.

Treatments*	Thermal processing	Minimal processing treatments		
		UV (min.)	US (min.)	OPE (µl/100 ml)
Control	0	0	0	0
TP	90°C /5 min	0	0	0
UV15/US15/OPE	0	15	15	250
UV15/US30/OPE	0	15	15	250
UV30/US15/OPE	0	30	30	250
UV30/US30/OPE	0	30	30	250

*Control: raw juice untreated; TP: thermal processed; UV/US/OPE: minimally processed.

Table 2: Antioxidant compounds content and antioxidant activity of orange peel extract:

Parameter	Content
Ascorbic acid (mg/100 ml)	55.47
Total carotenoids content (mg/100 ml)	16.10
Total phenols content (mg/100 ml)	163.25
Antioxidant activity (%)	91.48

Table 3: Antimicrobial activity of orange peel extract (OPE) against different bacteria species:

	Zone of inhibition (mm)[2]				
Concentration Of OPE (µl)	*E. coli*	*Enterobacter*	*Pseudomonas aeruginosa*	*Bacillus subtillis*	*Aspergillus niger*
100	6	5	8	7	5
150	7	6	10	8	5
200	9	8	13	11	7
250	13	11	16	14	9

*OPE (orange peel extract).

Table 4: Effect of combined minimal processing treatments vs. thermal processing on physiochemical analysis of grapefruit juice:

Parameter	Treatment					
	Control	TP	UV15/US15/OPE	UV15/US30/OPE	UV30/US15/OPE	UV30/US30/OPE
PH	3.20^{a}±0.02	3.18^{a}±0.03	3.15^{a}±0.04	3.14^{a}±0.06	3.16^{a}±0.03	3.16^{a}±0.04
T. A (%)	2.17^{a}±0.03	2.14^{a}±0.02	2.17^{a}±0.04	2.19^{a}±0.03	2.18^{a}±0.05	2.16^{a}±0.03
T.S. S (Brix)	9.37^{a}±0.04	9.36^{a}±0.06	9.36^{a}±0.03	9.37^{a}±0.05	9.35^{a}±0.04	9.34^{a}±0.07
NEBI	0.243^{d}±0.015	0.396^{a}±0.014	0.251^{d}±0.012	0.277^{d}±0.010	0.282^{c}±0.013	0.318^{b}±0.015

Values followed by different letters within the same Raw are significantly different (p< 0.05). T.S.S: Total soluble solids (Brix); T. A: Titratable acidity (%); NEBI: non-enzymatic browning index.

Table 5: Effect of minimal processing treatments vs. thermal processing on antioxidant compounds contents and antioxidant activity of Grapefruit juice:

Parameter	Treatment					
	Control	TP	UV15/US15/OPE	UV15/US30/OPE	UV30/US15/OPE	UV30/US30/OPE
Ascorbic acid (mg/100g)	37.35^{a}±0.15	13.52^{e}±0.11	33.20^{b}±0.13	32.92^{c}±0.16	33.07^{bc}±0.12	29.69^{d}±0.10
Total carotenoid content (mg/100mL)	98.11^{d}±0.44	58.12^{e}±0.40	111.74^{a}±0.47	111.25^{a}±0.43	107.65^{b}±0.49	104.62^{c}±0.38
Total phenolic Content (mg/100ml)	74.42^{e}±0.31	46.84^{f}±0.29	98.47^{b}±0.28	102.94^{a}±0.36	97.65^{c}±0.39	92.28^{d}±0.34
Antioxidant activity (%)	68.38^{e}±0.27	47.59^{f}±0.12	72.63^{a}±0.18	70.93^{b}±0.29	69.92^{c}±0.24	69.11^{d}±0.16

Values followed by different letters within the same Raw are significantly different (p< 0.05).

Table 6: Effect of minimal processing treatments vs. thermal processing on color of grapefruit juice:
Values followed by different letters within the same Raw are significantly different (p< 0.05

Parameter	Treatment					
	Control	TP	UV15/US15/OPE	UV15/US30/OPE	UV30/US15/OPE	UV30/US30/OPE
*L**	27.06^{a}±0.24	25.06^{e}±0.21	26.77^{ab}±0.23	26.62^{bc}±0.20	26.41^{c}±0.22	26.07^{d}±0.21
*a**	9.87^{a}±0.06	6.43^{d}±0.010	9.14^{b}±0.07	9.18^{b}±0.09	9.08^{b}±0.06	8.05^{c}±0.08
*b**	11.53^{a}±0.11	10.29^{c}±0.14	11.49^{a}±0.10	11.44^{a}±0.12	11.37^{a}±0.11	11.14^{b}±0.13
ΔE	—	4.14^{a}±0.10	0.78^{d}±0.06	0.86^{d}±0.07	1.06^{c}±0.08	2.15^{b}±0.05

Table 7: Effect of minimal processing treatments vs. thermal processing on microbial inactivation analysis of Grapefruit juice (log CFU/mL):

Parameter	Treatment					
	Control	TP	UV15/US15/OPE	UV15/US30/OPE	UV30/US15/OPE	UV30/US30/OPE
Coliform count	0.95	Nil	Nil	Nil	Nil	Nil
Total bacterial count	2.25	Nil	1.26	Nil	Nil	Nil
Mould and Yeast count	2.54	Nil	1.54	Nil	Nil	Nil

Table 8: Effect of combined minimal processing treatments vs. thermal processing on sensory evaluation of grapefruit juice:

Parameter	Treatment					
	Control	TP	UV15/US15/OPE	UV15/US30/OPE	UV30/US15/OPE	UV30/US30/OPE
Color	8.60^{a}±0.18	5.40^{d}±0.15	7.90^{b}±0.14	7.50^{c}±0.10	7.40^{c}±0.13	7.30^{c}±0.11
Taste	8.40^{a}±0.16	5.30^{e}±0.19	7.40^{b}±0.12	7.30^{bc}±0.14	7.10^{cd}±0.10	7.00^{d}±0.13
Odor	8.50^{a}±0.17	5.10^{e}±0.17	7.80^{b}±0.13	7.20^{c}±0.11	7.20^{c}±0.14	6.90^{d}±0.12
Consistency texture	8.30^{a}±0.14	6.30^{e}±0.12	7.95^{b}±0.10	7.40^{c}±0.13	7.80^{b}±0.11	7.10^{d}±0.15
over all acceptability	8.40^{a}±0.15	5.60^{e}±0.18	7.70^{b}±0.11	7.30^{cd}±0.12	7.40^{c}±0.13	7.10^{d}±0.11

Values followed by different letters within the same Raw are significantly different (p< 0.05).

تأثير معاملات التصنيع البسيطة مقارنة بالمعاملة الحرارية على خصائص الجودة لعصير الجريب فروت

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الملخص العربي

أجريت هذه الدراسة لتقييم تأثير استخدام معاملات مدمجة بين الأشعة فوق البنفسجية والموجات فوق الصوتية ومستخلص قشور البرتقال كتقنيات تصنيع بسيطة مبتكره مقارنة بالمعاملة الحرارية لحفظ عصير الجريب فروت وتأثير ذلك على الخصائص الفيزيوكيميائية والميكروبيولوجية والحسية لعصير الجريب فروت. وكانت عصير الجريب فروت غير معاملة (كنترول) ومعامله بالحرارة (90°م / 5 دقائق) وأربع معاملات تصنيع بسيطه مدمجه (موجات فوق صوتيه بتردد 35 كيلو هرتز عند 25 درجة مئوية لمدة 15 و 30 دقيقة - معاملة بالأشعة الفوق بنفسجية بجرعة 3.525 جول / م2 عند 25 درجة مئوية لمدة 15 و 30 دقيقة - 250 ميكرولتر من مستخلص قشر البرتقال). وقد أظهرت النتائج أن المعامله الحرارية ومعاملات التصنيع البسيطة لعصير الجريب فروت لم تؤثر على خصائصه الفيزيوكيميائية. وكان تدهور حمض الاسكوربيك في عصير المعامل بمعاملات التصنيع البسيطه (11.11- ٪20.5) لكنه كان أقل تدهورا من العصير المعامل بالحراره (٪63.8). وقد زادت قابلية استخلاص الكاروتينات والبولي فينولات في العصير المعامل بمعاملات التصنيع البسيطه بشكل كبير مقارنة بعينة العصير المعامل بالمعاملة الحرارية والتي احتوت على أقل محتوى من الكاروتينات والبولي فينول، وقد انعكس ذلك في تسجيل نشاط مضاد للأكسدة عالي لمعاملات التصنيع البسيطة. كما أظهرت المعاملة الحرارية ومعاملات التصنيع البسيطة انخفاضً كبيرًا في الحمل الميكروبي مقارنة بالكنترول، وقد حازت العينات التي تمت معاملتها بمعاملات التصنيع البسيطة على درجات حسية أقل من الكنترول ولكنها كانت أعلى من المعاملة بالحرارة. وأخيرا أشارت النتائج التي تم الحصول عليها الي تأييد استخدام تقنيات التصنيع البسيطة لحفظ عصير الجريب فروت بدون التأثير على خصائص جودته.

الكلمات الاسترشادية: المعاملة الحرارية، الأشعه الفوق بنفسجية، الموجات فوق الصوتية، مستخلص قشر البرتقال، معاملات التصنيع البسيطة، عصير الجريب فروت