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Improvement in the Quality of Pomegranate Leather

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Abstract

New different products from pomegranate and roselle calyces either alone or blends of them with different ratio were prepared and dehydrated in leather form. The effect of processing on physiochemical, phytochemical composition and quality were evaluated. The results declared that roselle calyces extract includes the highest values of phytochemical compounds such as anthocyanin, total phenol, total flavonoid content, total tannic and acidity in comparison with pomegranate juice and pomegranate concentrate. These values were 321.50, 2007.72, 1336.33, 243.10 mg/100 g and 11.42% as citric acid respectively.

Pomegranate and pomegranate roselle leather were also evaluated for their physiochemical composition and phytochemicals. The results showed that the replacement of pomegranate concentrate with roselle calyces extract for produced pomegranate leather recorded improvement in quality attributes (anthocyanin, total phenol, total flavonoid and total tannic) of the pomegranate leather by addition of roselle extract. The present study demonstrated that adding roselle extract to the processed pomegranate leather will improve the loss in the quality attribute.

Keywords: Leather quality; Pomegranate juice; Pomegranate concentrate; Physiochemical; Phytochemical composition; Roselle calyces extract

Introduction

Color is one among the important attribute for consumer while food selection. Color stability, especially after heat and light presentation, remains a challenge. Therefore, natural and synthetic colorants are added to processed food aim to remunerate for varying quality and to restore initial appearance, but also to color food, which would otherwise be unattractive or unappealing [1].

Pomegranates are found mainly in Upper Egypt particularly in Asuit Governorate due to a result in extension of land reclamation using newly introduced varieties, to overcome the increasing amount of export. Where the total production exceeded 89,000 tons in 2012 [2].

The arils are the consumable piece of the fruit, which comprise of around 80% juice and 20% seed. Arils constitute 52% of total bear fruit (w/w), and the fresh juice contains 85.4% moisture and significant measures of total soluble solids, sugars, reducing sugars, anthocyanins, phenolics, organic acids, ascorbic acid, vitamins, polysaccharides, proteins, and essential minerals [3].

White pomegranates arils are reported in China, India and Iran. However, the term “white” in those reports seemed to relate mostly to non-red pomegranates, and it is not clear whether “white” reflects partial or total disappearance of anthocyanins in the pomegranates [4]. Due to rise in cost and lower production profit, pomegranates are stored in the form of various products, mainly fruit juice and concentrate [5].

Turfani et al., [6] reported that the anthocyanin content of pomegranate juice reduced substantially after filtration. The loss of total anthocyanins was up to than 20% higher in filetrated juice as compared to unclarified juice.

Sugar and sugar dissolution products have been found to be effective on accelerating anthocyanin breakdown and enhance non-enzymatic browning during heated processing [7].

Thermal handling is the most common way to extend the shelf life of fruit juices by abolishing microorganisms and enzymes. Heating right after pressing inhibits native polyphenol oxidase (PPO) enzymes that cause brown color structure by oxidizing polyphenols [8].

Roselle pertains to the family of Malvaceae, it is a high quality source of natural bioactive content and color, providing even higher levels compared with traditional sources such as raspberries and blueberries [9].

Roselle is used in production of jelly, jam, juice, wine, syrup, gelatin, pudding, cake, ice cream, and as flavoring agent . It’s a red color unique flavor to make high-quality food products, nutraceuticals, cosmeceuticals, and pharmaceuticals. The calyces, stems, and leaves are acidic in flavor, juice from the calyces is a healthy drink due to its high resource of bioactive components [10].

The interest for natural antioxidants has been raised due to the consumer to worry with the safety than using of artificial antioxidants. Anthocyanin, in addition, is phenolic compound contributed as antioxidants by giving hydrogen to highly reactive radicals thereby discontinuing further formation of oxidation products [11].

Fruit leather is a traditional fruit product that is normally produced in Anatolia, Armenia, Lebanon, Syria, Arabia, and Persia and is familiar with different names such as ‘Bastegh’, ‘Qamar el deen’, ‘Bestil’, and ‘Fruit Leather’. Many fruits are used for pestil production such as grape, mulberry, apricot, pear, and kiwi-fruit. Fruit leather is a sweet product with great nutrient content such as mineral, vitamins, and regard as a rich energy source due to its carbohydrate content. The main to interfere with fruit leather processing is the production of fruit juice

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concentrate, pouring the fruit leather mix into molds at certain sample thickness and drying [5].

Therefore, the main objective of this investigation was to evaluate using of roselle extract for improving the quality attribute and phytochemicals content of pomegranate leather during produced.

Materials and Methods

Materials

Pomegranate juice concentrate (PJC): Freshly harvested and ready to eat pomegranate fruits (*Punica granatum* L.) were purchased from a local market (Minia, Egypt) and used for the study.

Arils were removed manually in a stainless steel container, juice was mechanically extracted. The filtered juice was used for the preparation of pomegranate juice concentrate.

Pomegranate juice (PJ) was concentrated by using open pan heating at 85 ± 5°C and stirred constantly. During the heating process, samples were reached to 65 ± 2 °C Brix then canning in glass bottle and chilling until used.

Roselle calyces extract (RE): Freshly harvested roselle calyces (*Hibiscus sabdariffa*) which were obtained from Horticulture Research Laboratory, Mallawi Agricultural Research station (Minia, Egypt) were used for the study. Dried on the day of purchase, using a mixed-mode forced convection solar dryer at 50 ± 3°C. Roselle calyxes were grounded by using a grinder.

The proportion of roselle calyxes to water extraction included 1:10 ratio of dried calyxes to water. Meanwhile, the temperature was 50°C for 30 min to extract roselle [12]. The extract was filtered with a cheese cloth.

Producing of pomegranate leather (PL): The supplemented pomegranate Leather was prepared by replacing the pomegranate concentrate with roselle calyces extract at 20%, 30% and 50% levels (w/w) and transferred to a braiser. Then boiled water-starch mixture (The concentration of starch was 4 g/100 g of the total amount) was added slowly to the braiser by agitating under moderate heating (70°C). The mixture was heated five more minutes, then was put into stainless steel trays (10 cm in diameter) which were 3 mm in thickness, in such a way that trays were on clothes for a while, then the trays were taken off and drying was carried out on the clothes. At the end of the drying, (Pl was removed from cloth by slight moistening to backside of the cloth, a drying process was ended when samples reached 15% moisture [5].

Analytical methods: Total soluble solids and pH values were determined according to AOAC [13].

Titratable acidity was determined according to Adekunte et al. [14].

Non-enzymatic browning (NEB): Five grams of the samples were drenched in 100 ml of 60% ethanol for overnight. The Non-enzymatic browning was evaluated at 420 nm [15].

Determination of anthocyanins: Anthocyanin (as cyanidin-3-glycoside mg/100 g) pigment was measured following the method described by Ranganna [16].

Determination of total phenols: Estimation of phenols content was carried out according to Musa et al. [17] using Folin-Ciocalteu reagent.

Determination of total flavonoids: Total flavonoid content was analysed by the colorimetric method as described by Abu Bakar et al. [18].

Determination of total tannic: Method of Schanderl [19] was used for determination of water-soluble tannins by the colorimetric method.

Determination of color: The color characteristics of samples were measured by a color difference meter (model color Tec-PCM, USA) using different color parameters (L,a,b) according to Francis [20]. In addition, the numerical total color difference (ΔE), hue angle and color intensity (chroma) were calculated using the following equations:

$$\Delta E=[(L-L0)^2+(a-a0)^2+(b-b0)^2]^{1/2}$$

$$\text{Hue angle}=[\tan^{-1}(b/a)]$$

$$\text{Chroma}=[(a^2+b^2)]^{1/2}$$

Where: L0, a0 and b0 were the L, a, and b values of the reference sample which here is the control one.

Results and Discussion

Physiochemical and phytochemical of raw materials

Physiochemical and phytochemical of roselle calyces extract, pomegranate juice, and pomegranate concentrate are recorded in Table 1. The data showed that the total soluble solid of roselle calyces extract was 7.0 ± 1.1 %, pH value was 3.13 ± 0.3, acidity content was 11.42 ± 1.2% as citric acid and NEB value was 2.10 ± 0.2 respectively. These results were in agreement with those reported by Abou-Arab et al. [21].

The results in Table 1 recorded that the Roselle calyces extract had the highest content of phytochemical 321.50 ± 1.24, 2007.72 ± 2.00, 1336.33 ± 1.30 and 243.10 ± 1.9 mg/100 g anthocyanin, total phenol, total flavonoid content, and total tannic respectively. Roselle calyx a rich source of bioactive compounds such as organic acids, anthocyanin, flavonoid and polyphenols, some of them with antioxidant properties [22].

Concentrated pomegranate juice by using open pan heating cause change in physiochemical and phytochemical of pomegranate juice (Table 1). The result indicated that total soluble solids, acidity, and NEB value increased from 16.75 ± 1.3, 5.24 ± 1.5 and 0.971 ± 0.09 in pomegranate juice to 60 ± 1.8, 8.10 ± 1.09 and 1.25 ± 0.15 in pomegranate concentrate respectively. On the other hand pH value decreased from 3.85 ± 0.2 in pomegranate juice to 3.40 ± 0.25 after concentrate pomegranate juice. These results were in agreement with those reported by Akpinar-Bayizit et al. [23] who recorded that the total titratable acidity (as citric acid) in pomegranate juice concentrate was between 5.80-14.27% and pH of the pomegranate juice concentrate as 1.34-3.60.

Phytochemical content (total phenol, total flavonoid and total tannic) increased from 162.48 ± 1.5, 307.38 ± 1.2 and 77.13 ± 1.09 in pomegranate juice to 211.12 ± 1.6, 1099.25 ± 1.2 and 143.151.5 mg

Raw materials Parameter*	Roselle calyces extract	Pomegranate juice	Pomegranate concentrate
TSS	7.0 ± 1.1	16.75 ± 1.3	60 ± 1.8
pH	3.13 ± 0.3	3.85 ± 0.2	3.40 ± 0.25
Acidity%	11.42 ± 1.2	5.24 ± 1.5	8.39 ± 1.09
NEB	2.100 ± 0.2	0.971c ± 0.09	1.250 ± 0.15
Anthocyanin**	321.50 ± 1.24	45.06 ± 1.15	8.10 ± 0.95
Total phenol**	2007.72 ± 2.00	162.48 ± 1.5	211.12 ± 1.6
Total flavonoid**	1336.66 ± 1.30	307.38 ± 1.2	1099.25 ± 1.2
Total tannic**	243.10 ± 1.9	77.13 ± 1.09	143.15 ± 1.5

*Means of three determinations ± SD
**mg/ 100 g

Table 1: Physiochemical and phytochemical of raw materials.

/100 g after concentrate pomegranate juice. However, concentrated pomegranate juice led to degradation of anthocyanin content from 45.06 ± 1.15 to 8.10 ± 0.95 mg/100 g. These results were in agreement with those reported by Hamid et al. [24].

Color parameters of raw materials

The Hunter color parameters (L), (a) and (b) are widely used to describe color changes in food materials. However, it is recommended to use hue angle and chroma as more practical measures of color. The color changes can also be expressed as a single numerical value ΔE. This value defines the magnitude of the total color difference. Preferred colors are those closest to the original color of samples.

The results of color parameters for Roselle calyces extract (RE), Pomegranate juice (PJ) and Pomegranate concentrate (PC) are presented in Table 2. The results showed that the color parameters L, a, b, hue angle and chroma for roselle calyces extract were 21.66, 68.51, 26.66, 24.31 and 73.45, while were 28.55, 30.07, 24.69, 39.38 and 38.91 for pomegranate juice, respectively. Whereas pomegranate juice concentrate recorded 3.67, 15.76, 3.67, 13.10 and 16.18 values with decrease in initial values of juice color (very dark red) intensity in respect of L^*, a^* and b^* values were noted while preparing the concentrate from the juice by open pan concentration techniques. Reduced color intensity might be due to increased non-enzymatic browning of juice, pigments destruction and increased soluble solids during thermal processing at high temperature as observed by Yilmaz et al. [5].

Physiochemical and phytochemical of pomegranate and pomegranate roselle Leather (Pl)

The results given in Table 3 indicated that the Non-Enzymatic Browning (NEB) value increased in pomegranate leather with addition of an increased percentage of roselle extract from 1.52 in pomegranate leather to 3.65 in pomegranate with 50% roselle extract leather. Formation of browning compounds during dehydration in the oven determined the final color of the leathers, due to Maillard reactions [25].

The pH value decreased in pomegranate leather with an increased percentage of roselle extract from 3.98 for pomegranate leather to 3.57 for pomegranate with 50% roselle extract leather. This results could be due to the content of organic acid in roselle extract 11.42% (Table 3). These results were in agreement with those recorded by Forough et al. [26] who reported that the reduction in pH can be due to an increase in the concentration of organic acids. However, the total titratable acidity (%citric acid) increased in pomegranate leather with an increased percentage of roselle extract from 3.08 in pomegranate leather to 3.52 in pomegranate with 50% roselle extract leather. These results were in a good agreement with the findings of Abou-Arab et al. [21] and Da-Costa-Rocha et al. [27] reported that roselle calyces extracts contain a high percentage of organic acids. The variety of the pomegranate used and evaporation applied in the production caused an increase in the acidity.

The results in Table 3 declared that there is a great improvement in anthocyanin content of pomegranate leather with an increased ratio of roselle extract from 5.97 mg/100 g in pomegranate leather to 47.18 mg/100 g in pomegranate with 50% roselle extract leather. These results clearly showed that the Roselle extract is rich in anthocyanins, and could be used as a good source for red color (anthocyanin) for many foods. The concentration of fruit juices by conventional evaporation methods results in color degradation and loss of most volatile compounds with a consequent remarkable qualitative decline due to thermal effects.

A gradual increase in the total phenols content of pomegranate leather was recorded with the advancement of roselle extract ratio Table 3. The highest content was recorded in the pomegranate leather with 50% roselle extract (1222.63) followed by pomegranate leather with 30% roselle extract (1054.30), pomegranate leather with 20% roselle extract (967.25) and 100% pomegranate leather (855.57 mg/100 g) respectively. Hence roselle extract could be incorporated as nutritive ingredients in the production of healthy food products. These results were in a good agreement with those reported by Tontul I, et al. [28]. They recorded that the total phenolic content of the pomegranate leather ranged from 852.36 to 1327.02 mg/100 g dw.

The initial concentration of total flavonoids in pomegranate

Color parameters*	Roselle calyces extract	Pomegranate juice	Pomegranate concentrate
L (Lightness)	21.66 ± 0.39	28.55 ± 1.70	3.67 ± 1.01
a (redness/greenness)	68.51 ± 0.58	30.07 ± 1.13	15.76 ± 0.9
b (yellowness/blueness)	26.66 ± 1.84	24.69 ± 1.35	3.67 ± 1.2
ΔE**	-	0	35.57
Hue angle***	24.31	39.38	13.10
Chroma****	73.45	38.91	16.18

Means of three determinations ± SD

** $\Delta E = [(L - L_o)^2 + (a - a_o)^2 + (b - b_o)^2]^{\frac{1}{2}}$

*** $Huge\ \text{angle} = [\tan^{-1}(b/a)]$

**** $Chroma = [(a^2 + b^2)]^{1/2}$

Table 2: Color parameters of raw materials.

Treatments	pH	Acidity%	NEB	Anthocy anin mg/100 g	Total phenols content mg/100 g	Total flavonoids mg/100 g	Tannic mg/100 g
Pl 100%	3.98 ± 0.20	4.08 ± 1.5	1.52 ± 0.03	5.97 ± 0.45	4340.0 ± 1.5	2057.3 ± 1.1	142.7 ± 1.05
R 20%	3.93 ± 0.05	3.22 ± 2.01	1.59 ± 0.002	10.11 ± 0.80	4835.8 ± 2.3	2137.1 ± 1.4	163.0 ± 1.08
R 30%	3.83 ± 0.10	3.47 ± 1.8	2.09 ± 0.004	18.81 ± 0.58	5099.2 ± 1.8	2281.7 ± 1.7	175.6 ± 0.8
R 50%	3.61 ± 0.21	3.52 ± 1.58	3.65 ± 0.002	47.18 ± 0.90	5579.7 ± 2.5	4114.4 ± 0.9	217.3 ± 1.05

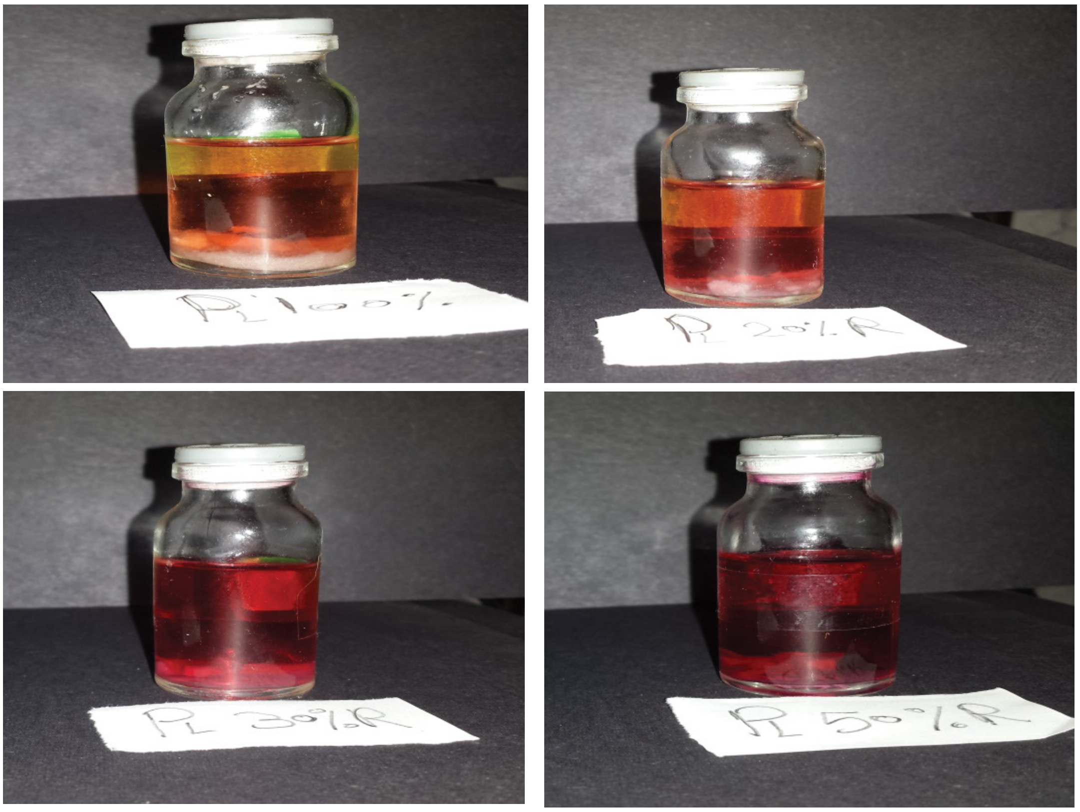
PL:100% pomegranate leather
R20%: Pomegranate leather with 20% Roselle extract
R30%: Pomegranate leather with 30% Roselle extract
R50%: Pomegranate leather with 50% Roselle extract
Means of three determinations ± SD

Table 3: Effect of add (20, 30, 50%) roselle extract in Physiochemical and phytochemical of pomegranate leather (Pl).

Color parameters*	Treatments			
	P100%	R20%	R30	R50%
L (Lightness)	16.50 ± 1.02	20.55 ± 1.1	22.60 ± 1.09	25.59 ± 1.15
a (redness/greenness)	19.70 ± 1.1	22.30 ± 1.05	27.70 ± 1.2	30.01 ± 1.09
b (yellowness/blueness)	7.40 ± 0.95	9.01 ± 1.01	10.02 ± 1.05	11.0 4 ± 1.1
ΔE**	23.49	19.23	16.04	13.96
Hue angle***	19.90	41.29	63.54	52.42
Chroma****	21.04	24.05	29.46	31.98

PL: 100% pomegranate leather
R20%: pomegranate leather with 20% Roselle extract
R30%: pomegranate leather with 30% Roselle extract
R50%: pomegranate leather with 50% Roselle extract
*Means of three determinations ± SD

Table 4: Effect of add (20, 30, 50%) roselle extract in color parameters of pomegranate leather (Pl).



PL: 100% pomegranate leather **R20%:** pomegranate leather with 20% Roselle extract **R30%:** pomegranate leather with 30% Roselle extract **R50%:** pomegranate leather with 50% Roselle extract.

Figure 1: Methanolic extract of pomegranate and pomegranate roselle leather.

leather samples (Table 3) varied from 1472.46 (pomegranate leather) to 3414.72 (pomegranate leather with 50% roselle extract) mg /100 g as Quercetin. During technological processes, the amount of flavonoids may increase by releasing from food matrix [29]. These results are in accordance with those obtained by Alaga [30]. They indicated that flavonoids were found to be the most abundant bioactive agent in *Hibiscus sabdariffa L* (Roselle), water extract content 1.08% and 2.41% in ethanol extract quercetin.

The results in Table 3 indicated that the tannic content increased in pomegranate leather with increased percentage ratio of roselle extract from 142.70 in pomegranate leather to 217.27 mg/100 g in pomegranate with 50% roselle extract leather. These results were in agreement with those recorded by Okereke et al. [31] who recorded that the phytochemicals were extracted from the dried calyces of *Hibiscus sabdariffa* using solvent extraction method. The result revealed tannins content was 17% as tannic acid. On the other hand Fernandes, et al. [32] reported that the tannin contents were detected between pomegranate cultivars ranging from 26.0 to 325.3 mg TAE/100 ml.

Color parameters of pomegranate and pomegranate roselle Leather (Pl)

The L, a, b, ΔE, hue angle and chroma values of the leather were in (Table 4 and Figure 1). The lower L, a, b, hue angle, and chroma values were, therefore, that showed in the pomegranate leather without roselle extract addition (16.50,19.70,7.40,19.90 and 21.04) respectively. Conversely, the L,a,b, hue angle and chroma values increased with increasing ratio roselle extract addition 20%,30%,50%. The 50% ratio recorded higher color parameters L, a, b and chroma values (25.59,30.01,11.04 and 31.98) followed by roselle extract addition ratio 30% (22.60,27.70,10.02 and 29.46) and (20.55,22.30,9.01 and 24.05) respectively in 20% roselle extract addition ratio. From the previous results, it can be declared that the addition of 30% extract roselle extract during the production of pomegranate leather gave the best results in almost color and other quality attributes studied.

These results were in a good agreement with the findings of Hussein et al. [27], Mgaya-Kilima et al. [33] and Da-Costa-Rocha et al. [34] which reported that roselle calyces extracts contain a high percentage of pigments are commonly used in the production of jelly, juice, jam, wine, syrup, gelatine, pudding, cake, ice cream, and flavoring.

Conclusion

The presented study demonstrated that roselle extract is added (as a natural colorant) during the production of pomegranate leather to compensate for varying quality, restore initial appearance and improvement of the content of phytochemicals. Pomegranate leather with 30% roselle extract is desired because of its have the best color parameters and high content of the phytochemical component.

Author's Contributions

The participants in the research roles are equal, where everyone participated in the idea of research and the compilation of scientific material and conduct experiments and physiochemical and phytochemical analysis of materials and products and record results and performed the work of statistical analysis and writing and publishing research.

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