



## NOVEL FUNCTIONAL POMEGRANATE LEATHER REPLACEMENT WITH DEEP PURPLE CARROT F1 JUICE

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### ABSTRACT

The objective of this work was to produce a healthy and acceptable natural product. Novel pomegranate leathers were prepared using four concentrations (5%, 10%, 15%, and 20%) of deep purple carrot F1 juice (DPCJ). Physicochemical and phytochemical parameters including total soluble solids, acidity, pH, non-enzymatic browning (NEB), chromatic coordinates ( $L^*$ ,  $a^*$  and  $b^*$ ) as well as total color difference ( $\Delta E$ ), total sugar, total phenol (TP), total flavonoid (TF), anthocyanin, total carotene, and antioxidant activity were determined. The best phytochemical parameters and organoleptic characters were obtained from LPCR 10% and LPCR 15% (total phenol: 285.66, 314.00 mg/ g dw.; total flavonoid 26.57, 27.35mg/g dw.; total anthocyanin: 18.3, 22.00 mg/g dw. and carotene: 3.2, 3.4mg/g dw.) for replacement with 10% and 15% DPCJ, respectively. A high positive and significant correlation was observed between leathers bioactive components, total anthocyanin ( $r^2=0.95$ ), total phenol ( $r^2=0.93$ ), carotene ( $r^2=0.93$ ) as well as total flavonoids ( $r^2=0.88$ ) with DPPH. Based on the counts of microbial flora (bacteria, molds, and yeast), LPCR were considered microbiologically safe. The present work may help to solve the problem of color loss during the manufacture of pomegranate. Also the production of a novel natural product with high nutritional quality.

**Keywords:** Leather, Deep Purple Carrots, Phytochemicals, Chromatic Coordinates Antioxidant activity, Anthocyanin.

### INTRODUCTION

Fresh pomegranate (*Punica granatum*) is known to be an excellent source of vitamins, minerals, fibers, carbohydrates, and other bioactive

compounds especially anthocyanin. It has recorded a history of pharmacological properties which can be attributed to its rich reservoir of phytochemicals. These nutritional

values greatly depend on the quality and quantity of their nutritive substances (Kark ,2011). Anthocyanin less pomegranates arils are reported in many countries.

So far, there is no clear answer to the total or partial absence of anthocyanin in the arils (Ben-Simhon et al.2015; Luo et al. 2018). Discoloration of some species of pomegranate is considered as one of the most quality defects. Due to the processing of pomegranate, there is loss of acceptability up to 20% of anthocyanin (Turfani et al. 2012; Amir et al.2018).

In addition to flavor, texture, and economic considerations, color is believed to be one of the most important characteristics that affect consumer acceptance of foodstuffs. Therefore, both natural and artificial colorings are added to processed foods to compensate for the different quality and restore the initial appearance.

Deep purple carrot (*Daucuscarota L. sp. Sativus var. atrorubens*) is considered as a natural food colorant, offering a final color that can vary from deep violet to bright red. Deep purple carrots are considered as a good natural antioxidant and a good source of anthocyanin pigments (1750 mg/kg) (Mazza and Miniati, 1993 and Moustafa et al.2016). Thus, the deep purple carrot is crucial for the quality of processed fruits. Moreover, it is relatively stable to both heat and pH change (Stintzing et al.2002; El-Gharably ,2005; Assous et al.2014). Moreover, it has a protection effect against cancer and many diseases

(Vini and Sreeja,2015 and Vendrame and Klimis-Zacas 2019). $\beta$ -Carotene accounted for 3.2 mg/kg in purple or black carrots (Ahmad et al.2019). It has been estimated that the average dietary intake of polyphenols is 1058 mg per day for males and 780 mg per day for females, comprised as follows: 50% hydroxycinnamic acids, 20% to 25% flavonoids, and 1% anthocyanins (Chun et al. 2012).

Fruit leathers are one of the preserved forms of fruit, which have high nutritional value. Apricot and pomegranate are commonly produced as leather in a different place in the world. Tezcan et al. (2009) have reported that leathers are rich in vitamins, minerals and they have a high content of fibers, carbohydrates with low fat content. The above mentioned parameters are highly related to the processing technology (using of temperatures for concentration and drying) and the quality of raw materials (Bharambhe et al.2009; Vatthanakul et al.2010; Yilmaz et al.2015). Latif and Abdel-Aleem,( 2019) produced and improved the quality of pomegranate leather (anthocyanins, total phenol, total flavonoid, and total tannic )by the addition of roselle extract. Furthermore, these components have attractive colors and flavor. People and children eat leathers as snacks or desserts (Irwandi 1998; Vatthanakul et al.2010) as well as special healthy snacks without sugar are a product for diabetic children or adults (Bharambhe et al. 2009).

The aim of the current study was to solve pomegranate processing defects by replacement pomegranate

juice with different levels of deep purple carrot F1 juice which has a high content of stable anthocyanin and carotene. Production of a novel functional leather from pomegranate and deep purple carrot F1.

## **MATERIALS AND METHODS**

### **Chemicals**

Methanol, ethanol, acetone, anthocyanin standards and 2,2- diphenyl- 1- picrylhydrazyl- hydrate (DPPH) were purchased from Sigma Chemical Co. (St. Louis, Mo, USA), and Folin–Ciocalteu reagent and gallic acid were obtained from Merck Co. (Darmstadt, Germany). Pre-gelatinized starch was used as a raw material in leather production. All the reagents were of analytical grade

### **Pomegranate juice (PJ):**

Fresh pomegranate fruits (*Punicagranatum*) that were harvested and ready to be eaten were bought from a local market (Minia, Egypt) and used in the study. Arils were manually removed in a stainless steel container, and the juice was mechanically extracted. Filtered juice was used to prepare different concentrations.

### **Deep purple carrot F1 juice (DPCJ):**

Fresh deep purple carrot (*Daucuscarota L. sp. Sativus var. atrorubens*) was obtained from the farm of the Agriculture College of Minia University (Minia, Egypt). The juice was extracted mechanically, filtered with a cheesecloth, and filtered juice was used to prepare the leathers.

### **processing of concentration of pomegranate and purple carrot**

Pomegranate concentrate was prepared by replacing the pomegranate juice with carrot juice at 5, 10,15, and 20% levels (w/w).

Pomegranate juice and carrot juice were concentrated by using open pan heating at  $85\pm 5^{\circ}\text{C}$  and stirred constantly. During the heating process, samples were reached to  $65\pm 2$  °Brix then canning in a glass bottle and chilling until used.

### **Processing of leather :**

The supplemented pomegranate Leather was prepared as shown in Fig. (1) by replacing the concentrated pomegranate with carrot juice at 5, 10,15, and 20% 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 (  $70^{\circ}\text{C}$ ). The mixture was heated for five more minutes. Then put into stainless steel trays (10 cm in diameter) which were in thickness (3 mm) in such a way that trays were on clothes for a while, then the trays taking off and drying were carried out on the clothes. At the end of the drying, The pomegranate leathers were

removed from cloth by slight moistening to backside of the cloth, the drying process was ended when samples reached 15% moisture. ( Yilmaz, et al., 2015).

**Quality attributes:** Soluble solid content (°Brix) was determined using AOAC

( 2002). Acidity and pH were determined using a Schott Titroline

easy pH meter previously calibrated with pH4.0 and 8.0 buffer solutions according to AOAC( 2002). The acidity of fresh juices and leathers were determined by titration using NaOH 0.1 N. Acidity was expressed

as a percentage of citric acid AOAC (2002). Non-enzymatic browning (NEB) was evaluated at 420 nm through drenched five grams of the samples in 100 mL of 60% ethanol overnight (Ranganna,1986).

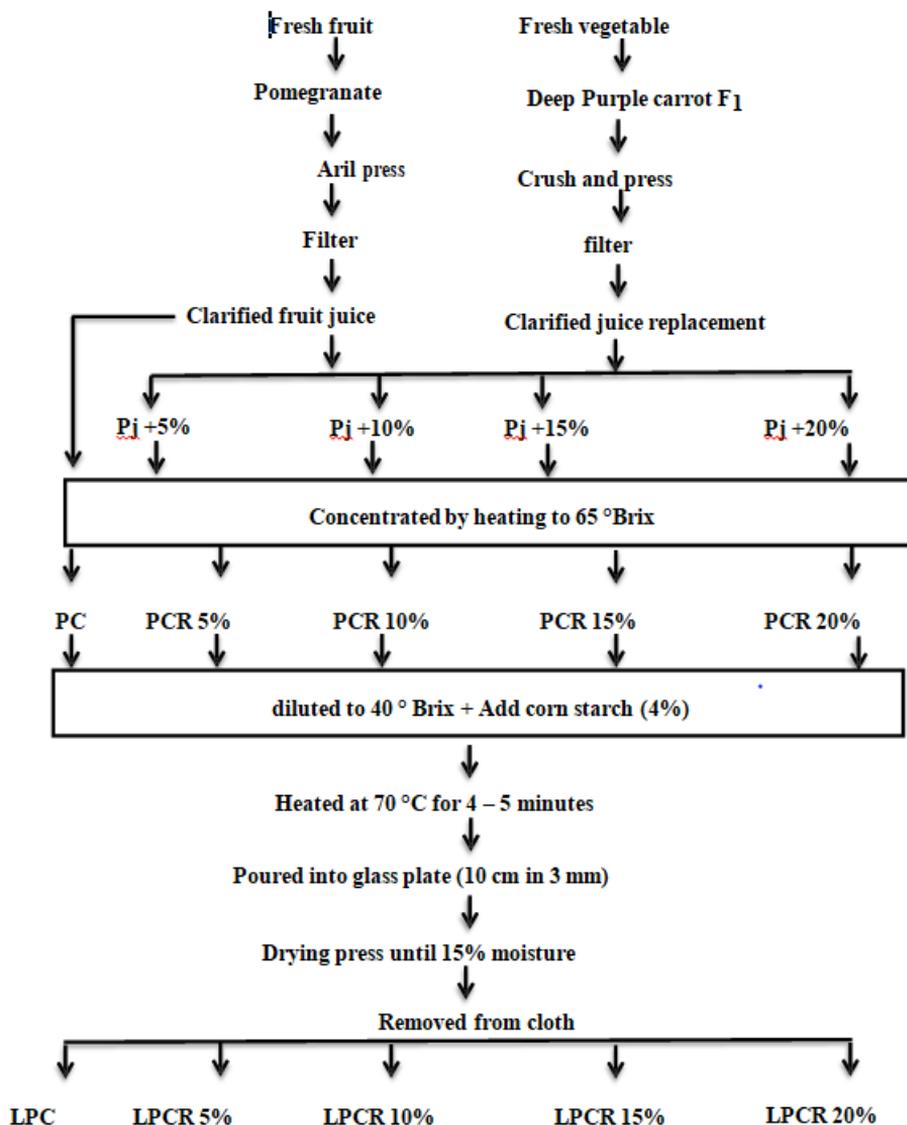


Fig. (1) Flow sheet for preparation of leathers

### **Determination of color:**

Color characteristics were measured by a color difference meter (model color Tec-PCM, USA) using different color parameters (L\*, a\*, and b\*) according to the method described by Francis (1983). Also, the numerical total color difference ( $\Delta E$ ), hue angle, and color intensity (chroma) were calculated using the following equations:

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

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

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

$\Delta L$  ( $L-L_0$ ),  $\Delta a$  ( $a-a_0$ ) and  $\Delta b$  ( $b-b_0$ ), whereas  $L_0$ ,  $a_0$  and  $b_0$  were the L, a, and b values of the reference sample which is the control one.

### **Antioxidant activity, anthocyanins, carotene, total flavonoids, and total phenol content**

The radical scavenging activity was evaluated using the DPPH method (Brand-Williams et al. 1995), with the modification of using a reaction time of 15 min. The

decrease in absorbance was measured at 515 nm using a UV-Visible Spectrophotometer (Helios Gamma model, UVG 1002E, Merckers Row, Cambridge, UK). Anthocyanin (as cyanidin-3- glycoside mg/100g) pigment was measured following the method described by Ranganna(1986). Total flavonoid (TF) content was analyzed as described by Abu Bakar et al. (2009). The total phenolic compounds (TP) were quantified using the Folin-Ciocalteu reagent (Singleton et al., 1999). Absorbance was measured at 760 nm using a Spectrophotometer (Helios, ThermSpectronic, Cambridge, UK).

Results were expressed as milligrams of gallic acid per gram of dry weight

### **Microbiological analysis**

All samples were analyzed for counts of aerobic mesophilic microorganisms, molds, and yeasts. Samples (10 g) were ground and homogenized with peptone water (0.1g/100mL) for 45 s. A series of dilutions were carried out in duplicates. According to (APHA, 1994) nutrient agar media was used for determining the total bacterial count, whereas yeast and mold counts were carried out using (potato dextrose agar). Number of bacterial colonies, yeast, and molds were counted, after incubation at 37°C/48 h for bacteria and 25°C / 72 h for yeast and molds. Colony counts were expressed as colony-forming units CFU/g(Torres et al., 2015).

### **Sensory evaluation**

Sensory evaluation of different pomegranate leathers was carried out using the methods of Torres et al., (2015) by ten trained staff members. Attributes were color (10), texture (10), taste (10), and flavor (10). The overall acceptability was calculated from the total scores of the tested attribute.

### **Statistical analyses**

The results were evaluated by statistical analysis using the Statgraphics 18.0 software (Manugistics, Inc., Rockville, MD, USA). In order to find out if the differences in the mean values estimated were statistically significant, the one-way analysis of variance was applied (ANOVA). Later, homogeneous groups were determined with Duncan's multiple

range test (at significance level ( $\alpha=0.05$ ). Data were also processed by principal component analysis (PCA). All the experiments were repeated three times.

## **RESULTS AND DISCUSSION:**

### **Quality attributes**

Results showed that soluble solids of pomegranate juice (PJ) were in the average 15 °Brix, 17 °Brix for DPCJ F1, and 85 °Brix for leathers. The pH of the pomegranate leather ranged between 1.4 and 2.1. Tontul and Topus (2018) reported that the pH of pomegranate leather was in the range between 3.61-3.68, the pH of leather replacement (LR) was lower than that of the pomegranate leather (PL). This may be related to the pH value of DPCJ F1. The results obtained in this study are in good agreement with Onsekizoglu (2013), who reported that the pH of the leather was mostly dependent on the fruit juices ingredients used in its formulation and the process conditions.

In this research, it was found that pomegranate leather had acidity between 1.4 and 2.1 for control and LPCR20% respectively. As a result of that, the total acidity increased in LPCR with an increased percentage of replacement from 5% to 20%. The decrease in acidity levels of pomegranate leather was due to the replacement of DPCF1 to the leather. These results are in good agreement with that found by Connor et al. (2002a), who reported that acidity of leathers was in the range of 0.9 ~ 2.5%.

Sugar content (Table 1) is an important parameter influencing taste, although it is highly influenced by organic acid content as well replacement of 5%, 10%, 15% and 20% of DPCF1 juice led to the increment of the sugar content to the percentage of 72.4, 74.2, 75 and 77.5, respectively compared to the control value which was 69.4. These results were closed with Cagindi and Otlis (2005) who recorded little variations of carbohydrate (73.7 to 82.4%) between different varieties of leather.

### **Color and NEB**

Color may be considered as an important nutritional character, as it is often associated with the amount of total anthocyanin content. Changes in color characteristics (Table 2) were observed including L\*, a\*, b\*,  $\Delta E$ , hue angle, and chroma values after production. Lightness values (L\*) of PLs ranged from 14.37 to 9.39 while redness values (a\*) ranged from 15.88 to 26.14. A clear decrease in (L\*) values were observed with minimize % DPCF1 juice replacement. These findings may be considered as a result of decreased anthocyanin and total phenol contents. Yang and Atallah (1985) observed that increased L\* values indicated a higher loss of anthocyanin from thermal degradation through drying.

A considerable decrease of (a\*) values were observed in control compared with all replacement leather (Table 2). Anthocyanin is responsible for the red color in leathers and stable at low pH. On the contrary, (b\*) values showed a progressive increase from 10.57 to 14.66. Chroma (C\*) reflects color brilliance or purity and

shows intensity of color saturation from control to LPCR 20%. It was positively associated with the anthocyanin content. Huge angle behavior is related to the change of  $a^*$  and  $b^*$  and showed a decreased trend. Our result is well supported with the findings of Sadilova et al. (2006).

The  $\Delta E$  values, which are indicators of total color difference, showed that there were significant differences ( $p < 0.05$ ) in color between control and replacement leathers (Figure 3). In general, the  $\Delta E$  was highly significantly different in LPCR 20% compared to PL. In contrast, no significant difference in  $\Delta E$  values was found between supplemented leathers ( $p > 0.05$ ). These results clearly demonstrated that the color stability of PLs depends on the replacement percentage of DPCJ.

The results of the color variation for leathers were correlated with the NBE obtained during the time of monitoring. (Table 2) shows that there was a gradually increase in the NBE from 0.26 to 0.47 after drying in control to LPCR 20%, respectively. Other studies had shown that the NBE was correlated to antioxidant activity (Kallithraka et al. 2009). Moreover, higher browning resulted also was found with a higher concentration of gallic acid. Various authors estimated that decrease in the value of  $L^*$  was associated with an increase in the darkening of food (Lozano and others 1994; Lopez and others 1997).

#### Bioactive components

A gradual increase in the total phenols content of pomegranate leather was recorded with the

advancement of deep purple carrot (Table 1). The results showed that the highest content was recorded in LPCR 20%, (314 mg/100g) compared with control pomegranate leather (PL) (170.66 mg/100g). These results are in good agreement with those reported by Tontul and Topuz. (2018). However, the initial concentration of total flavonoids in PL samples varied from 17.94 (control) to 27.35 (LPCR 20%) mg /100 g dw. as quercetin. The data obtained here indicated that, flavonoids were the most abundant bioactive agent and maybe provide daily adult needs because, it is difficult to compare flavonoid intakes in older adults, this is due to the differences in dietary assessment methods and the use of different FCDBs. Nevertheless, flavonoid intakes are reported to range from around 21.2 mg/day to 191.2 mg/day in elderly adults (Chun et al., 2012).

(Table 1) showed the effect of replacement of DPCF1 juice on total carotenoid content in pomegranate leathers. Total carotenoid content in leathers were 2.7, 2.9, 3.2 and 3.4 in in LPCR 5%, LPCR 10%, LPCR 15% and LPCR 20%, respectively.

Purple carrot anthocyanin content was about (41%) as comprise acylated cyaniding which was stable against heat (Stintzing et al., 2002). The stability of pomegranate leather anthocyanin at 60 C on duration time of processing is evident in (Table 1) and declared that there was a great improvement in anthocyanin content of PL with an increased percentage of deep purple carrot.

Remaining of anthocyanin was 30% in PL and raised to 58%, 64,

78%, and 89% of the total anthocyanin with increasing supplementation of deep purple carrot percentage with 5 %, 10 %, 15% and 20, respectively. The results agree with Assous (2014). From previous data, it was clearly that the deep purple carrot juice was rich in anthocyanins ( $86.98 \pm \text{mg}/100 \text{ mL}$ ). This could be used as a good source for red color for processed foods. Hence deep purple carrot could be incorporated as nutritive ingredients in the production of healthy food products.

The DPPH method is a very effective and common in order to determine antioxidant activity as % of various products .Also (Table 1) showed that all leathers possess a preventative impact against DPPH free radicals. Significant differences were observed the levels of antioxidant activity among products ( $p < 0.05$ ). About 80% of RSA of fresh juices were identified. Drying caused a reducing effect on

antioxidant activity (Karaaslan et al. 2014). Replacement of leather with 20% DPCF1 juice had the highest quenched DPPH<sup>•</sup> (36%), while LPCR 15%, LPCR 10% and LPCR 5% quenched 31%, 28% and 25%, respectively. The reduced ability to scavenge at DPPH roots in enhanced control (23%). These findings may be due to the low content of flavonoids and phenols compared to other products. As shown through correlation analysis (Table 3), there was a strong positive correlation between DPPH and total flavonoid content ( $r^2 = 0.88$ ). The antioxidant activity of PLs was due to the presence of total phenol and total flavonoids and anthocyanin (Table 2). Phytochemical antioxidants were supposed to oppose the negative effects of oxidative stress either by acting directly as an antioxidant or by activating/persuading the cellular antioxidant enzyme mechanisms (Leja et al., 2013).

Table(1): Quality attributes ,phytochemicals and antioxidant activity of pomegranate leathers replacement

	pH	Acidity%	Total Sugar %	TP	TF	Anthocaynin*	Carotene**	DPPH % inhibition
control	3.70 <sup>b</sup>	2.10 <sup>a</sup>	69.40 <sup>d</sup>	170.66 <sup>c</sup>	17.94 <sup>c</sup>	5.60 <sup>c</sup>	0.00 <sup>c</sup>	23.33 <sup>c</sup>
LPCR 5%	3.78 <sup>b</sup>	2.00 <sup>b</sup>	72.40 <sup>c</sup>	215.66 <sup>d</sup>	22.45 <sup>b</sup>	11.97 <sup>d</sup>	2.70 <sup>d</sup>	25.33 <sup>d</sup>
LPCR 10%	3.81 <sup>a</sup>	1.90 <sup>c</sup>	74.20 <sup>b</sup>	239.00 <sup>c</sup>	24.80 <sup>a</sup>	13.80 <sup>c</sup>	2.90 <sup>c</sup>	28.00 <sup>c</sup>
LPCR 15%	3.87 <sup>a</sup>	1.70 <sup>d</sup>	75.00 <sup>b</sup>	285.66 <sup>b</sup>	26.57 <sup>a</sup>	18.3 <sup>b</sup>	3.20 <sup>b</sup>	31.00 <sup>b</sup>
LPCR 20%	3.99 <sup>a</sup>	1.40 <sup>c</sup>	77.00 <sup>a</sup>	314.00 <sup>a</sup>	27.35 <sup>a</sup>	22.00 <sup>a</sup>	3.40 <sup>a</sup>	36.00 <sup>a</sup>

Table(2):Color parameters of pomegranate leathers replacement

	L	A	B	Huge	Chroma	ΔE	NEB	TSS : Acid ratio
control	14.36 <sup>a</sup>	15.88 <sup>c</sup>	10.56 <sup>c</sup>	24.43 <sup>a</sup>	19.07 <sup>c</sup>	29.45 <sup>b</sup>	0.26 <sup>c</sup>	25.5
LPCR 5%	13.30 <sup>b</sup>	18.40 <sup>d</sup>	11.32 <sup>d</sup>	22.61 <sup>b</sup>	21.61 <sup>d</sup>	29.28 <sup>b</sup>	0.37 <sup>c</sup>	33.2
LPCR 15%	12.02 <sup>c</sup>	20.52 <sup>c</sup>	12.44 <sup>c</sup>	22.27 <sup>b</sup>	24.00 <sup>c</sup>	29.58 <sup>b</sup>	0.33 <sup>d</sup>	36.0
LPCR 15%	10.88 <sup>d</sup>	22.64 <sup>b</sup>	13.38 <sup>b</sup>	21.72 <sup>b</sup>	26.29 <sup>b</sup>	30.03 <sup>ab</sup>	0.41 <sup>b</sup>	41.1
LPCR 20%	9.39 <sup>c</sup>	26.14 <sup>a</sup>	14.66 <sup>a</sup>	20.61 <sup>c</sup>	29.97 <sup>a</sup>	30.91 <sup>a</sup>	0.47 <sup>a</sup>	48.9

Values are expressed as mean. Values with the same letter in the same column are not statistically different ( $p>0.05$ ). Total flavonoid (TF) content is expressed in mg of quercetin per 100 g and total phenols(TP) are expressed in mg of gallic acid per 100 g.\* expressed as total anthothyanin.\*\*expressed as  $\beta$ -carotein in mg of per 100 g

Table(3): Correlation coefficients between Phyto-chemical, Physo-chemical attributes, Radical Scavenging Activity (RSA) and each of the principal Components(PC1-PC3)

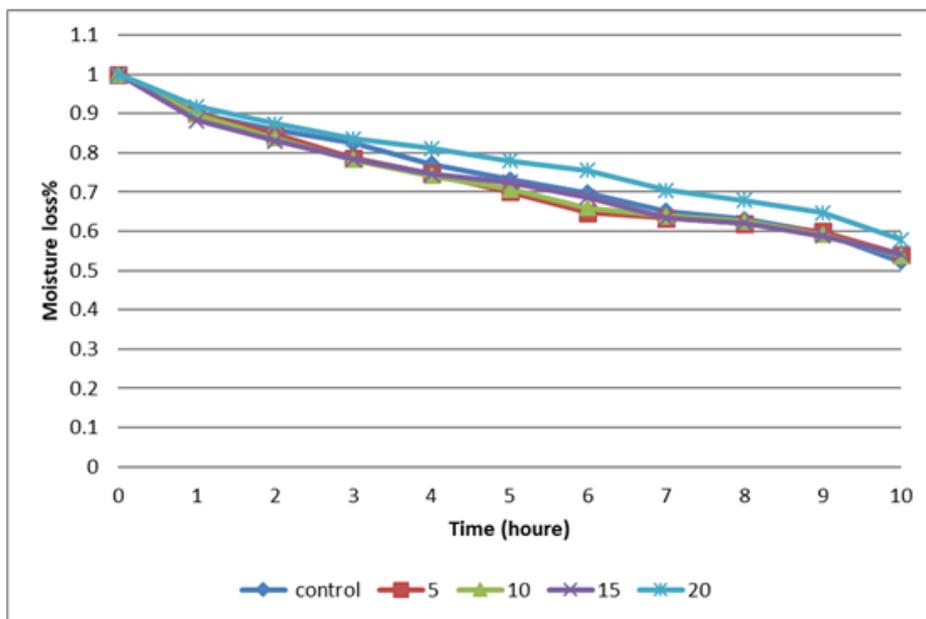
Variables Correlation	Phytochemical				Physiochemical				RSA	Principal Component			
	TF	TP	Anthocyanin	Carotene	Acidity	Total Sugar	NEB	Chroma	L	DPPH	PC1	PC2	PC3
TF	1.000	.955	.918	.940	-.930	.920	.765	.900	-.902	.880	.839	.337	.420
TP		1.000	.979	.983	-.961	.970	.862	.965	-.942	.929	.702	.470	.480
Anthocyanin			1.000	.992	-.980	.970	.941	.977	-.960	.954	.594	.614	.492
Carotene				1.000	-.988	.978	.917	.962	-.943	.926	.666	.586	.419
Acidity					1.000	-.946	-.908	-.940	.939	-.908	-.670	-.599	-.383
Total Sugar						1.000	.888	.969	-.936	.942	.617	.520	.506
NEB							1.000	.897	-.872	.883	.366	.831	.406
Chroma								1.000	-.957	.987	.542	.514	.641
L									1.000	-.961	-.554	-.478	-.617
DPPH										1.000	.488	.719	.488

\* Correlation in italics were used for interpretation  $P \leq 0.05$  according to Pearson correlation.

### Kinetic drying

Figure (2) showed that the percentage of moisture loss during leather drying at 60°C was affected by

the rate of Replacement of DPCF1 juice to produce LPCR and had a great effect on the speed of moisture loss during dehydration



**Fig (2) the percentage of moisture loss content during leathers drying at 60°C.** (LPC: Leather pomegranate concentrate; LPCR5%: Leather pomegranate concentrates replacement 5% purple carrot F1; LPCR10%: Leather pomegranate concentrates replacement 10% purple carrot F1; LPCR15%: Leather pomegranate concentrates replacement 15% purple carrot F1; LPCR20%: Leather pomegranate concentrates replacement 20% purple carrot F1).

Moisture loss in all treatments in the first hours of drying up to 6 h was continuously increased by measuring the drying time. The moisture loss rate increased with LPCR 5%, LPCR 10%, and LPCR 15% compared with the loss rate of moisture in the control samples, while the increase for replacement with 20% DPCF1 juice led to a decrease in the rate loss of moisture. This finding agrees with Bchir et al. (2010).

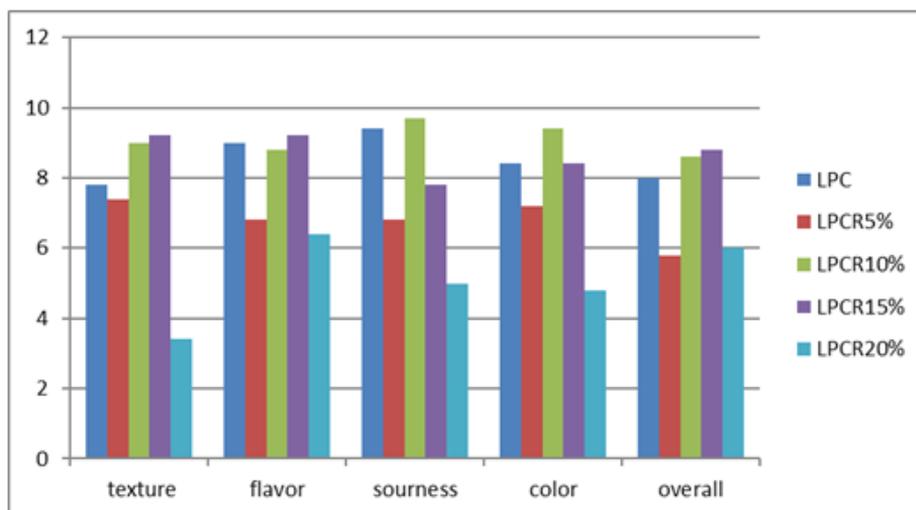
### Organoleptic properties:

Measurement of sensory profiles as color, sourness, flavor, texture, and general product acceptance of LPCR compared with pomegranate leather are very important to determine consumer acceptability for leather. Sensory data was plotted to show trends and patterns for all ten attributes. Figure 3 shows that LPCR 10% and LPCR 15% had the best scores and overall acceptability compared with LPCR 5% and LPC. On the other hand, the lowest overall

acceptability grades recorded for LPCR 20% probably due to darker color, taste, and smell of deep purple carrot.

Total soluble solid : Acid ratio is considered as an important factor for sensory perception of fruit products. This is undergoing acidification and is

related to preservative and antioxidative effects (Adedeji, et al.2006 and Hui, 2008). Total soluble solid: acid ratio showed in (Table 2) wherein LPCR 15% had 60% more than TSS: acid ratio compared with LPC.



**Fig (3) Sensory characteristics of pomegranate leather samples. (LPC: Leather pomegranate concentrate; LPCR5%: Leather pomegranate concentrates replacement 5% purple carrot F1; LPCR10%: Leather pomegranate concentrates replacement 10% purple carrot F1; LPCR15%: Leather pomegranate concentrates replacement 15% purple carrot F1; LPCR20%: Leather pomegranate concentrates replacement 20% purple carrot F1).**

### Microbiological quality

The predominant fungi found in fresh PJ and DPCJ samples were found to be yeasts (molds were not detected). As expected, the predominant microbial contaminants recovered were from various types of fruit juices and usually acid-tolerant micro-organisms (Tournas et al. 2006; Dede et al. 2007; Patrignani et al. 2009). After leathers processed, a steep decline in the growth rate of microbes was found to be half counts

from  $17 \times 10^4$  CFU/g in fresh juice mixture and remained lower than  $8 \times 10^4$  CFU/g in all leathers. Yeast and molds were not detected. This was due to several reasons such as high temperature applications, high sugar, and polyphenol concentration which have act antiseptic effect (Bayindirli et al.2006). Furthermore, high acidity in fruit leathers prevents the growth rate of microflora by limiting competition from other microbial groups and helps to maintain the color

and flavor of the leathers. Therefore, it is important from a processing or manufacturing point of view to use DPCJ (Garcia-Graellset al.1998; Bayindirli et al., 2006). Thus, these leathers were considered microbiologically safe.

### **Correlations and Principle Component Analysis**

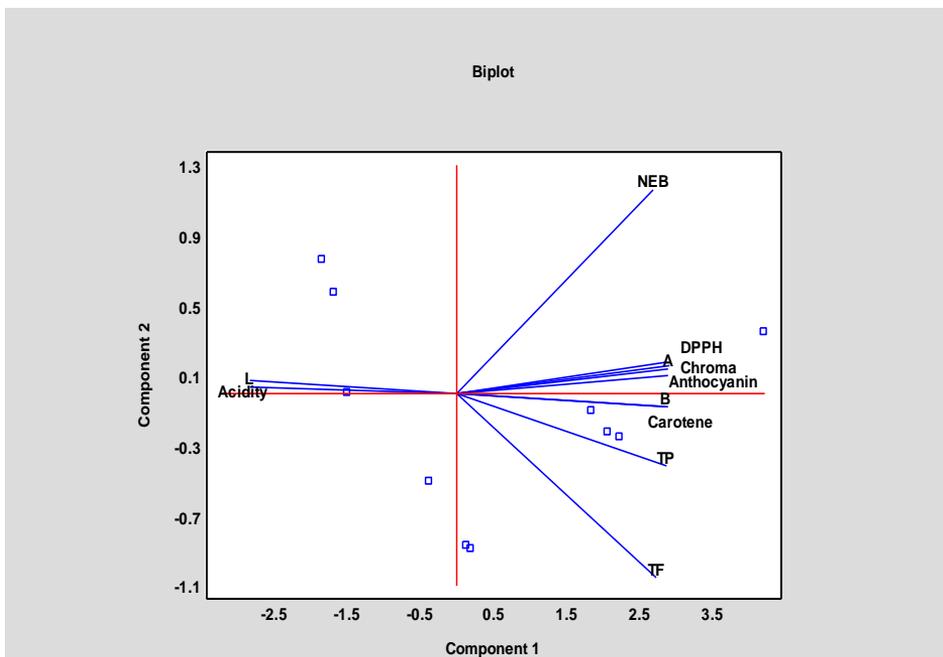
Table (3) shows the correlation among flavonoid, anthocyanin, total phenolic contents, DPPH radical scavenging activity, NEB,  $L^*$  and carotene of the different leathers. It was found that the contents of total phenolic, flavonoids, and NEB showed significantly positive correlations with anthocyanin, namely 0.979, 0.918, and 0.941, respectively. The results obtained in this study agree with Manzocco et al. (2001), who suggested that the determining phenolic compounds and anthocyanin have a more effective factor for the NEB obtained after processing. Negative correlations of the DPPH and anthocyanin assays with  $L^*$  and acidity were obtained. These results clearly demonstrate the importance of the above mentioned compounds which have antioxidant activity, as suggested by Elfalleh et al.(2011).

In order to have better understanding between the correlation among the physicochemical and phytochemical parameters of supplementation pomegranate leathers with deep purple carrot juice, the statistical technique Principal Component Analysis (Cabezas-Serrano et al.2009; Radziejewska-Kubzdela et al.2014) was employed.

In this study, the three principal components (PC1, PC2 and PC3)

explain 96 % of the total variability (Table 3), where PC1, PC2 and PC3 explain 37.9, 31.1 and 26.9% of the variability's, respectively. Each PC identifies the variables more strongly related to the leathers quality parameters and how they contribute to explain the total variability (Radziejewska-Kubzdela et al.2014). As can be seen in Figure 4 (Biplot of PC1 and PC2), PC1 was positively correlated with compositional factor, TF, TP, carotene and DPPH. On the other hand, this component was negatively correlated with acidity. In order of significance, the attributes that were more related to this component were TF (0.84), TP(0.72), DPPH(0.72) and acidity (-0.68). These are the main parameters that express the phytochemical quality of products and estimate the shelf life of products. PC2 was positively correlated with NEB and anthocyanin and negatively correlated with  $L^*$ . These results agree with what was found by Yang and Atallah (1985).

PC1+PC2 contain 69 % of the total variability of the set of original data regarding physicochemical and phytochemical parameters. The graph shows that compositional factors are positively correlated with TP, TF and DPPH (on the positive side of PC1) and negatively correlated with acidity. The attributes more related to PC2 were NEB (0.83), anthocyanin (0.62) and  $L^*$  (-0.49). Probably, acidity, NEB and  $L^*$  parameter could be used as a simple primary way to determine quality products.



**Fig.4 Biplot of contribution of all physico and phyto-chemicals investigation trials into the first and second components: acidity,  $L^*$ ,  $b^*$ ,  $a^*$ , chroma, NEB, TF, TP, carotene, anthocyanin and DPPH. PC1 and PC2 correspond to 69% of the total data variance.**

## CONCLUSION

To the best of our knowledge, this is the first time to use deep purple carrot F1 juice to ensure a stable anthocyanin with high acidity in the final fruit leather. Therefore, an innovative processing technique, protect the nutritional and functional compounds not only by using phenolics but also by providing carotene. A combination LPCR 10% and LPCR 15% formulation can, therefore, be recommended to produce high quality and acceptable leather. The end-product can be considered as a new natural product without preservatives. This approach will meet the consumer satisfaction

and requirements toward healthy and natural food products. Further work has to be carried out to investigate the stability and shelf life of pomegranate leathers and to identify the optimal suitable packaging under different storage conditions.

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## لفائف رمان وظيفية مستحدثة بالاستبدال بعصير الجزر البنفسجي

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1. قسم علوم الأغذية - جامعة المنيا - المنيا.

الهدف من البحث انتاج منتج مقبول طبيعي وصحي حيث جهزت لفائف رمان مستحدثة باستخدام أربع تركيزات 5% و 10% و 15% و 20% من عصير الجزر البنفسجي وتم تحديد مقاييس الخصائص الكيميائية الطبيعية والنباتية التي شملت المواد الصلبة الذائبة والحموضة و PH والتلون النبي غير الإنزيمي وأنظمة اللون (\*L\*, a\* and b\*) وأيضاً اختلافات اللون والسكريات الكلية والفينولات الكلية والفلافونويد الكلية وصبغة الأنثوسيانين والكاروتين الكلي ونشاط مضادات الأكسدة ومنحنى التجفيف والعد الكلي والتعقيم الحسي. ووجدت اختلافات في الخصائص لللفائف المستبدلة المختلفة. أفضل المقاييس للخصائص الطبيعية والحسية كانت في اللفائف المستبدلة 10% و 15% (الفينولات الكلية 285.66 و 23.07 و 314.00/g وزن جاف والفلافونويدات الكلية 27.35 و 26.574, ملجم/جم وزن جاف والأنثوسيانينات الكلية 18.3 و 22.00 ug/g وزن جاف والكاروتين 3.20 و 3.40 و mg/g وزن جاف مستبدلة بواسطة 10% و 15% عصير جزر بنفسجي على التوالي. ولوحظ علاقة معنوية بين المكونات النشطة والأنثوسيانين ( $r^2 = 0.95$ ) والفينولات الكلية ( $r^2 = 0.93$ ) والكاروتين  $r^2 = 0.93$  وأيضاً الفلافونويدات الكلية ( $r=0.88$ ) مع DPPH. وعلى أساس الميكروبيولوجي (بكتيريا - خمائر - فطريات). تعتبر اللفائف المستبدلة آمنة ميكروبيولوجياً. والبحث الحالي ربما يساعد في حل مشكلة فقد اللون أثناء تصنيع عصائر الرمان وانتاج منتج طبيعي مستحدث ذو جودة غذائية عالية.

