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STUDY ON NEW DRIED SHEETS PREPARED FROM CARROT, SWEET POTATO AND TOMATO.

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ABSTRACT

Vegetables of carrot, sweet potato and tomato are very acceptable for Egyptian consumer. Carrot, sweet potato and tomato contain higher nutritional values. Therefore, that has turned attention to prepare dried sheets from these mixtures together in order to take advantage of the quality of available factors in each. To take advantage of the lower pricesof these vegetables compared to some fruits such as apricot. With the optimization of some neglected raw materials and high nutritional value, such as sweet potato. The purpose of this research is to prepare new dried sheets from carrot, sweet potato and tomato.

The sheets prepared by mixing of the homogenized pulp of carrot, sweet potato, tomato and sucrose sugar together to obtain blends ratio at 6:2:2:2, 5:3:2:2, 4:4:2:2, 3:5:2:2 and 2:6:2:2 (w/w/w/w) respectively. The electric oven at 60±1ºC was used until the weight of samples was constant. It could be concluded that mixing of carrot, sweet potato, tomato, led to improve the nutritional value of the dried sheets and characteristics of the chemical, physical, sensory properties and antioxidants activity. The dried sheet at ratio 5:3:2:2 is preferable on base of physical, chemical and organ oleptical properties.

***Conclusively,** it is recommended to prepare dried sheets from carrot, sweet potato, tomato and sugarsby the ratio of (5:3:2:2) (w/ w/ w/w) on a commercial scale, where it has a high degree of overall acceptability than other samples, as well as well as based on chemical, physical, sensory properties economically.*

Keywords: Dried sheets,carrot, sweet potato and tomato.

INTRODUCTION

One of the main recommendations of these dietary guidelines is to increase the consumption of the foods including fruits and vegetables that are good sources of phytochemicals, such as carotenoids (lycopene and β-carotene), flavonoids and other phenolic compounds. These phytochemicals, especially polyphenols, have high free-radical scavenging activity, which helps to reduce the risk of chronic diseases, such as cardiovascular disease, cancer, and age related neuronal degeneration (Ames *et al*., 1993).

The free radicals are generated in the human body through aerobic respiration and exist in different forms, including superoxide, hydroxyl, hydroperoxyl, peroxyl and alkoxyl radicals. Generally, natural antioxidant enzymes in healthy individuals remove these free radicals (Rimbach *et al*., 2005). However, dietary antioxidants are helpful in assisting the body to neutralize free radicals. Therefore, it is important to consume a diet high in antioxidants, such as fruits and vegetables, to reduce the harmful effects of oxidative stress.

In recent years, carrots has been use steadily increasing because of their nutritional benefits (Yu*et al*., 2005).The carrot is an important rich source of antioxidants such as vitamins A, C, and E, β-carotene, carotenoids, flavoniods, flavones, phenolics compounds (Chen*et al*., 1996).

Sweet potato is a crop with rich nutritional values including carbohydrates, dietary fibers, minerals, vitamins, and antioxidants, such as phenolic acids, anthocyanins, tocopherol and β-carotene Woolfe (1992). They are an excellent source of vitamin A and a good source of potassium and vitamin C, B6, riboflavin, copper, pantothetic acid and folic acid (Hou *et al*., 2001).

In recent decades, the consumption of tomatoes has been associated with the prevention of several diseases (Sharoni and Levi, 2006 and Wilcox *et al*., 2003) mainly due to the content of antioxidants, including carotenoids (lycopene as well as β-carotene), ascorbic acid, tocopherol, and phenolic compounds (Periago *et al*., 2009).Tomato has been shown protective effects against cardiovascular disease, diabetes and stroke (Heinonen *et al*., 1998 and Scalbert & Williams, 2000). There is a close relationship between high consumption of tomatoes and tomato products and a decreased risk of human cancers and heart diseases (Giovannucci, 1999).

Therefore, this work aims to produce new dried sheets from carrot, sweet potatoes and tomatoes with a high quality and rich in carotenoids and lycopene and with maximizeusefulness of some vegetables such as sweet potato which available in large quantities with cheap price in Egyptian market.

MATERIALSANDMETHODS

1. *Materials*

Carrot (*Daucuscarota* L. sp. Sativusvar. atrorubens Alef.) used in this study were obtained from Ismailia Governorate, Egypt. Carrot were washed, trimmed and chopped lightly. The juice was obtained from the chopped carrot heated in water at 90ºC. The carrot was mixed with water in the ratio 2:1 (w/w) to facilitate the extraction of the juice by household centrifugal extractor (Moulinex T574, France).

Sweet potato was purchased from a local marketin Ismailia Governorate, Egypt. The roots were thoroughly washed with tap water, manually peeled. However the juice was obtained by heating in water at 90ºC. Sweet potato tuberswere mixed with water in the ratio 2:1 (w/w) to facilitate the extraction of the juice by household centrifugal extractor (Moulinex T574, France).

Tomato fruits were picked at the ripe stage from a certain farm in Kasasin, Ismailia Governorate. Therefore, fruits were washed, dried in air, cut into small parts. The tomato juice was extracted by (Moulinex T574, France), where it took five minutes blending to get the tomato juice. The juice was strained by stainless steel strainer, then strained by clean muslin cloth to get rid of seeds and peels for obtaining pure tomato juice.

2. Preparation of blends

The homogenized pulp of carrot, sweet potato, tomato and sucrose sugar were mixed together to obtain blends at the ratios 6:2:2:2, 5:3:2:2, 4:4:2:2, 3:5:2:2 and 2:6:2:2 to prepare five different blends. Both of these blends were treated with sodium meta bi sulphite 0.2% and sodium benzoate (0.1%). Pectin was added to the blends at ratio 0.1%. All prepared blends were adjusted to 14% total soluble solids and pH 4. The prepared blends were poured at stainless steel trays oiled with paraffin oil. The electric oven at 60±1ºC was used until the weight of samples was constant (Van arsdel *et al*., 1973). All dried sheets were packaged in poly ethylene bags inside aluminum foil closed and put in carton boxes with $CaCl_2$. Both of fresh sample and samples after dehydration were analyzed at 14 brix. All the analysis was determined of three replicates after processing and fresh sample as control.

3. Chemical analysis:

Total soluble solids (TSS), pH, total titrableacidity, ascorbic acid content, total and reducing sugars were analyzed according to methods described by the A.O.A.C. (2005). Color index was determined according to the methods described by Ranganna (1979).Color attributes (L, a & b) were evaluated according to Francis (1980) using a Minolta color Reader (CR-10, Minolta Co. Ltd., Japan.). Total phenolic content of juice was determined spectrophotometrically (a spectrophotometer model PU 8625) using the

Folin & Ciocalteu assay described by Vinson *et al*., (1995). Carotenoids were determined according to Bandyopadhyay *et al*., (2008).While lycopene was determined according to Barrett and Anthon (2001). Radical-Scavenging activity was measured according to the method of Brand-Williams *et al*., (1995). Sensory evaluation of the different tested juices was carried out using the method of Howard and Dewi (1995) by ten staff members (semi trained panelists) for color (10), odor (10), taste (10), mouthfeel (10) and appearance (10).The overall acceptability was calculated from the total scores of the tested attributes. Data was statistically analyzed according to the methods described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Data presented in Table (1) showed the chemical and physical composition for fresh and dried mixed blends at different ratios of carrot, sweet potato and tomato. The total soluble solids had adjusted at 14 brix in fresh and reconstituted sheets samples. It could be noticed that, pH values and non-reducing sugars were decreased after dehydration, while acidity, color index, reducing sugar and total sugars were slightly changed after drying compared to fresh treatments these attributed may be due to Maillard reaction. After dehydration the second and the third treatments recorded the lowest changes in chemical composition followed by the first treatment at ratio (6:2:2:2) but the fourth and fifth treatments at ratio (3:5:2:2) and (2:6:2:2) recorded the highest changes in chemical and physical composition. It was observed that addition of sweet potato with the mentioned ratio in second and third treatments were improved the quality control of these treatments after dehydration compared to treatments at ratios (3:5:2:2) and (2:6:2:2) which recorded the worst quality and higher increment in acidic taste. The positive correlation between acidic medium and increase of browning after dehydration may be due to reducing sugar which reacts with amino acid or peptides in Maillard reaction. The optimal total sugars and reducing sugars values in the treatments at ratios (3:5:2:2) and (2:6:2:2) after dehydration emphasis the positive correlation between thermal processing and increasing total sugars content. This effect may be due to the degradation occurred in complex sugars and fibers which led to formation of mono-saccharides, di-saccharides and tri-saccharides as a result of dehydration. This degradation increased by increasing of sweet potato ratio. There was an correlation between the reduced pH juices and increase in reducing sugars content, this may be due to degraded complex of sugars to reducing sugars as a result of acid medium and high

Table (1): Effect of drying proses on some chemical composition of mixed blends from carrot, sweet potato and tomato.

Analysis / Samples		Brix°	pH	Acidity %	O.D. at 420 nm	Reducing sugars %	Non-reducing sugars %	Total sugars %
B No.	**Blends ratio***	***Fresh juices at 14 Brix°***						
1	6:2:2:2	14[a]	4[a]	0.39[a]	0.035[a]	6.83[d]	4.44[a]	11.27[c]
2	5:3:2:2	14[a]	4[a]	0.36[a]	0.029[b]	7.14[d]	4.39[a]	11.53[bc]
3	4:4:2:2	14[a]	4[a]	0.31[b]	0.025[c]	8.22[c]	4.43[a]	11.67[ab]
4	3:5:2:2	14[a]	4[a]	0.30[b]	0.016[d]	8.88[b]	2.97[b]	11.85[ab]
5	2:6:2:2	14[a]	4[a]	0.28[b]	0.013[d]	9.53[a]	2.49[c]	12.02[a]
B No.	**Blends ratio***	***Dried samples after reconstitution at 14 Brix°***						
1	6:2:2:2	14[a]	3.86[b]	0.50[b]	0.086[c]	8.86[d]	2.53[a]	11.39[c]
2	5:3:2:2	14[a]	3.`92[a]	0.42[d]	0.063[e]	8.94[d]	2.89[a]	11.83[b]
3	4:4:2:2	14[a]	3.89[ab]	0.46[c]	0.077[d]	9.37[c]	2.64[a]	12.01[b]
4	3:5:2:2	14[a]	3.82[c]	0.54[a]	0.104[b]	10.28[b]	1.37[b]	12.65[a]
5	2:6:2:2	14[a]	3.77[d]	0.56[a]	0.116[a]	11.76[a]	1.30[b]	12.89[a]

*(Carrot: Sweet potato: Tomato: Sugar) (w/w/w/w)
Mean of treatments by Duncan's multiple range tests at 0.05 level, means with the same letter are not significantly different at 0.05 level.

temperature that happened during dehydration. It is well known that the existence of reducing sugars plays a major role in browning reactions. Also, sugar and sugar degradation products have been found to be effective on accelerating pigments breakdown (carotenoids and lycopene) and enhance non-enzymatic browning during thermal processing as reported by Cemeroglu *et al*. (1994) and Suh *et al*. (2003). These findings ascertained that addition of sweet potatoes in the treatments at the ratios (5:3:2:2) and (4:4:2:2) followed by (6:2:2:2) exhibited high quality attributes after dehydration. From Table (1) no significant differences were noticed in sucrose content in blends no 1,2 and 3 in fresh juices while the reducing sugar were significantly differenced in all blends ratio. With respect to acidity in fresh juices these were no significant differences in blends no 3,4 and 5. The same results were noticed in recovered dried samples.

Results presented in Table (2), illustrated the changes in ascorbic acid, total phenols, total carotenoids, lycopene and antioxidant activity in fresh and dried blends consist of carrot, sweet potato, tomato. Ascorbic acid is

Table (2): Effect of drying process on ascorbic acid and antioxidant activity for blends consists of carrot, sweet potato and tomato.

Analysis / Samples		Ascorbic acid (mg/100g)	Total phenols (mg/100g)	Carotenoids µg/100g	Lycopene µg/100g	Antioxidant activity (%)
B. No.	**Blends**	***Fresh juices at 14 brix***				
1	6:2:2:2	24.11[e]	155.84[a]	5806.75[a]	237.40[b]	48.21[a]
2	5:3:2:2	25.79[d]	132.91[b]	4669.08[b]	227.3[e]	45.36[b]
3	4:4:2:2	28.72[c]	95.89[c]	3806.55[c]	235.79[c]	38.14[c]
4	3:5:2:2	29.80[b]	82.58[d]	3122.64[d]	231.43[d]	35.84[d]
5	2:6:2:2	30.83[a]	42.94[e]	2333.60[e]	238.14[a]	31.58[e]
B No.	**Blends**	***Dried samples after reconstitution at 14 brix***				
1	6:2:2:2	12.79[c]	107.52[a]	4877.50[a]	170.92[c]	28.74[c]
2	5:3:2:2	17.31[a]	106.32[b]	4295.51[b]	193.20[a]	35.41[a]
3	4:4:2:2	14.00[b]	71.91[c]	3349.76[c]	183.91[b]	32.85[b]
4	3:5:2:2	11.35[d]	51.19[d]	2466.88[d]	157.28[d]	22.64[d]
5	2:6:2:2	9.93[e]	23.61[e]	1750.20[e]	150.02[e]	20.81[e]

*(Carrot: Sweet potato: Tomato: Sugar) (w/w/w/w)
Mean of treatments by Duncan's multiple range tests at 0.05 level, means with the same letter are not significantly different at 0.05 level.

an important component of our nutrition. It is used as an additive in many foods for its antioxidant capacity. Thus, the existence of ascorbic acid increases the quality and technological properties of food as well as the nutritional value (Solomon *et al*., 1995 and Larisch *et al*., 1998). However, ascorbic acid (vitamin C) is an unstable compound and under less desirable conditions, it decomposes easily (Fennema, 1977 and Lee & Coates, 1999). Degradation of ascorbic acid proceeds both aerobic and anaerobic pathways (Huelin, 1953 and Johnson *et al*., 1995) and depends upon many factors such as oxygen, heat and light (Robertson and Samaniego, 1986), storage temperature and storage time (Fellers, 1988 and Gordon & Samaniego-Esguerra, 1990). Oxidation of ascorbic acid occurs mainly during the processing of juices (Huelin, 1953), whereas, anaerobic degradation of ascorbic acid mainly appears during storage (Lee and Nagy, 1988a; Johnson *et al*., 1995 and Solomon *et al*., 1995) which is especially, observed in thermally preserved citrus juices. It is used to evaluate severity of heating applied on fruit juices during processing and taken into account for quality control (Lee and Nagy, 1988b).

Ascorbic acid increased with the reduction of carrot percent in mixture in fresh treatments. In addition, the optimal content of total phenols, total, carotenoids and antioxidant activity accompanied with the lower percent of sweet potato and higher level of carrot in fresh treatments. Phenolic compounds exhibit a wide range of physiological properties, such as anti-allergenic, anti-atherogenic, anti-inflammatory, anti-microbial, anti-oxidant, anti-thrombotic, cardio protective, and vasodilator effects (Balasundram *et al*., 2006). The mixture at ratio 2:6:2:2 appeared the highest content of lycopene in fresh treatments compared to the second treatment, which recorded the lowest content. All the determined parameters exhibited lower values after dehydration compared to fresh treatments. The blends at ratio 5:3:2:2 had superior ascorbic acid content, lycopene and antioxidant activity followed by the third and first treatments compared to the last two treatments that recorded the lower content of ascorbic acid lycopene and antioxidant activity after dehydration. Lycopene has been shown to have strong antioxidant activity; it exhibits the highest physical quenching rate constant with singlet oxygen; it induces cell-to-cell communication; and it modulates hormones, immune systems, and other metabolic pathways (Rao and Agarwal, 1999). It was observed that higher content of total phenols and total carotenoids accompanied with the higher percent of carrot in treatments after dehydration. In recent years, several carotenoids have health-promoting functions in humans displayed such as anti-oxidation, anticancer and protection against night blindness، aging and liver injury Rabah *et al*., 2004.

Phenols play an important role in human nutrition and are implicated with numerous biological properties including antioxidant (reducing agents, hydrogen atom donators, and singlet oxygen scavengers), anti-cancerandanti-atheroscleroticactivities (Rice-Evans *et al*., 1996; Strlic *et al*., 2002 and Seeram, *et al*., 2004). Interaction between the blends ratio drying process have a highest significant differences in the all items measured as shown in Table 2.

Attractive color is one of the most important sensory characteristics of fruits and its products especially, juices. The color change of a food product during drying is an indicator of how effect the drying conditions on the natural pigment composition or concentration. Hunter L*, a* and b* values were used to calculate total color differences, which indicated the magnitude of overall color differences between fresh and dried juices. Hunter ‘‘L’’ value is a measure of the color in the light–dark axis, this falling value indicates that the samples were turning darker. The lower in L value has a positive correlation with increasing browning of food material and pigments destruction (Ibarz *et al.*,1999; Maskan *et al.*, 2002; Suh *et al.*, 2003 and Ahmed *et al*., 2004).

The values of the reflected color parameters of fresh and dried blends are presented in Table 3. The refracted color parameters of L values were significantly (P <0.05) increase by higher percent addition of sweet potatoes in fresh blends. The L value of samples was reduced after drying compared to fresh sample. After drying the second treatments recorded higher L value followed by the third and the first treatments. Hunter a* value has good indicator for red color which acted lycopene pigments.

There was no significant difference between the second and third treatments in a value in fresh blends. Meanwhile, the second treatments had a significant difference with the third treatments at ratio 4:4:2:2 after dehydration. Hunter b* value has good indicator for yellow color which acted carotenoids pigments. The less b* value alterations in samples may be linked to less carotenoids decomposition and/or less formation of undesirable pigments as a result of drying conditions. The data presented in the Table (3) illustrated that b value was increased by elevated carrot in same order from first treatments to last treatment in fresh. There was a correlation between the reduced b values after dehydration and reducing in carotenoid content. All color items L*, a*, b*, hue and chroma values after dehydration refer that treatment at ratio 5:3:2:2 was the best treatment.

Table (3): Effect of drying on color values for blends consists of carrot, sweet potato and tomato.

Samples		L*	a*	b*	Heu	Chroma
B No.	**Blends ratio***	***Fresh juices at 14 brix***				
1	6:2:2:2	42.5[e]	17.3[b]	31.6[a]	61.30[a]	36.02[a]
2	5:3:2:2	43.1[d]	17.6[a]	30.7[b]	60.17[b]	35.08[b]
3	4:4:2:2	44.5[c]	17.7[a]	29.5[c]	59.03[c]	34.40[c]
4	3:5:2:2	45.3[b]	16.8[c]	27.7[d]	58.76[d]	32.39[d]
5	2:6:2:2	46.4[a]	17.2[b]	25.5[e]	55.99[e]	30.75[e]
B No.	**Blends ratio***	***Dried samples after reconstitution at 14 brix***				
1	6:2:2:2	38.3[c]	12.5[c]	24.6[c]	63.06[c]	27.59[c]
2	5:3:2:2	41.2[a]	13.3[a]	27.6[a]	64.43[a]	30.81[a]
3	4:4:2:2	39.7[b]	13.1[b]	26.7[b]	63.86[b]	29.74[b]
4	3:5:2:2	37.8[d]	11.1[d]	20.3[d]	61.33[d]	23.13[d]
5	2:6:2:2	36.1[e]	10.2[e]	18.3[e]	60.86[e]	20.95[e]

*(Carrot: Sweet potato: Tomato: Sugar) (w/w/w/w)

Mean of treatments by Duncan's multiple range tests at 0.05 level, means with the same letter are not significantly different at 0.05 level.

The change in sensory attributes immediately after preparing fresh blends and dehydration were scored in Table 4. Data presented in Table (4) illustrated that the first three treatments had no significant differences in data between them. All sensory attributes decreased after drying, higher overall acceptability scores were noticed at ratio 5:3:2:2 followed by 4:4:2:2 there is no significant differences between these treatments.

Table (4): Effect of drying process on sensory attributes for blends consists of carrot, sweet potato and tomato.

Samples		Taste 10	Odor 10	Color 10	Mouth feel 10	Appearance 10	Overall acceptability 50
B No.	**Blends**	***Fresh juices at 14 Brix°***					
1	6:2:2:2	10^{a}	10^{a}	10^{a}	10^{a}	9.5^{a}	49.4^{a}
2	5:3:2:2	10^{a}	10^{a}	10^{a}	9.5^{b}	9.5^{a}	48.8^{b}
3	4:4:2:2	10^{a}	9.5^{b}	10^{a}	9.5^{b}	9.5^{a}	48.2^{c}
4	3:5:2:2	9.5^{b}	9.3^{bc}	10^{a}	9.2^{bc}	9.2^{a}	47.1^{d}
5	2:6:2:2	9.5^{b}	9.2^{c}	10^{a}	9^{c}	9.2^{a}	46.7^{e}
B No.	**Blends**	***Dried samples after reconstitution at 14 Brix°***					
1	6:2:2:2	8.3^{ab}	8.1^{b}	8.4^{bc}	8^{bc}	8.6^{b}	41.4^{c}
2	5:3:2:2	8.8^{a}	8.5^{a}	8.8^{a}	8.6^{a}	9.1^{a}	43.8^{a}
3	4:4:2:2	8.6^{ab}	8.3^{ab}	8.6^{ab}	8.3^{ab}	9^{a}	42.8^{b}
4	3:5:2:2	8.1^{b}	7.6^{c}	8.1^{c}	7.9^{c}	8.2^{c}	39.9^{d}
5	2:6:2:2	8.0^{b}	7.5^{c}	7.7^{d}	7.5^{d}	8^{c}	38.7^{e}

*(Carrot: Sweet potato: Tomato: Sugar) (w/w/w/w)
Mean of treatments by Duncan's multiple range tests at 0.05 level, means with the same letter are not significantly different at 0.05 level.

Conclusively, it could be concluded that, the mixed blended dried sheet at ratio 5:3:2:2and 4:4:2:2 carrot: sweet potato: tomato are preferable on base of chemical, organoleptical as well as the economic view of prices.

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دراسة على لفائف جديدة مجففة معدة من الجزر والبطاطا والطماطم

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تحظي الخضروات مثل الجزر والبطاطا والطماطم بقابلية عالية لدي المستهلك المصري. الجزر والبطاطا والطماطم تحتوي على نسبة عالية من المغذيات. لذلك تم إعداد لفائف مجففة ناتجة عن خلطهم معا للاستفادة من عوامل الجودة المتوفرة في كل منهم والاستفادة من انخفاض اسعارهم مقارنة مع بعض الفواكه مثل المشمش. الغرض من هذا البحث تعظيم الاستفادة من بعض المواد الخام المهملة ذات القيمة الغذائية العالية مثل البطاطا عن طريقإعداد لفائف مجففة جديدة من الجزر والبطاطا والطماطم. تمإعداد الرقائق المجففة عن طريق خلط اللب المجنس لكل من الجزر والبطاطا والطماطم والسكر معا للحصول على مخاليط منهم بنسب ٢:٢:٢:٦ و ٢:٢:٣:٥ و ٢:٢:٤:٤ و ٢:٢:٥:٣ و ٢:٢:٦:٢ (وزن: وزن: وزن: وزن). تم استخدام فرن التجفيف علي درجة ٦٠ ± ١°م لحين الحصول على وزن ثابت للعينات.

وقد استنتج من نتائج هذا البحث أن اللفائف المجففة المعدة من خلط الجزر والبطاطا والطماطم قد حدث بها تحسين القيمة الغذائية والخصائص الكيميائية والحسية والمضادة للأكسدة لتلك اللفائف. انتاج اللفائف المجففة عند نسبة خلط ٥:٣:٢:٢ أعطي أفضل النتائج من حيث الخصائص الطبيعية والكيمائية و الحسية.

التوصية: يوصي بإعداد لفائف مجففة من الجزر والبطاطا والطماطم و السكر معا بنسبة (٥:٣:٢:٢) (وزن: وزن: وزن: وزن) على نطاق تجاري حيث انها حازت علي درجات تفضيل عالية عن باقي عينات اللفائف المجففة. وذلك على أساس التحاليل الكيمائية والطبيعية والحسية.