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Extraction of Natural Pigments from Food-Industrial Waste and their Use in the Manufacture of Jelly Candy for a Child

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ABSTRACT

This study evaluated the potential of the carrot peels, beetroot peels, and spinach stem as a waste to prepare a juice from there and it was the manufacturing of jelly candies at levels 10.0, 20.0, and 30.0 ml from each juice and compared with control jelly candy using 30.0 ml water. The results indicated that the carrot, beetroot, and spinach juice had contained rich amounts from minerals content, vitamins (E and C), total phenolic acids, total flavonoid compounds, and antioxidant activity. Thus, it could be used these juice to manufacture jelly candy, and sensory properties, color, and texture analysis profiles were determined in each jelly candy from each juice at different levels. The results reported that the jelly candy from beetroot gives the best results for sensory properties, color, and texture analysis profile followed by carrot and spinach jelly candies. The results suggest that carrot and beetroot, spinach as waste were utilized to prepare juices are a rich source of nutrients and bioactive compounds thus can be used these juice as a nutrition value and color to produce jelly candies for a child.

Keywords: *Carrot peels, Beetroot peels, Spinach stem, Waste, Pigment, Jelly candy*

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1. INTRODUCTION

Color is one of the measures of quality and also of the nutritional content of foods (**Suliman, *et al.*, 2018; Al Mazroea, *et al.*, 2018; Mohsein, *et al.*, 2019; Pham, *et al.*, 2020**). Thus, the aim was to add color to foodstuffs to be attractive, as well as to make the consumer buy the product. Moreover, a wide range of permitted artificial colors used as food additives has been put into effect in most countries. Therefore, consumers have requested that foods be as "natural" as possible to increase their awareness of the ingredients in their foods. Also, the demand for natural colors is increasing due to their familiarity with the therapeutic and medicinal properties and their benefits, and also because of the diseases that artificial colors cause **(Chakraborty *et al.,* 2019).**

Colored additives are widely used in the food industry to give the consumer an attractive appearance to buy. However, these substances pose a risk to human health if one is based on buying them too hard. Therefore, methods of adding artificial colorants to foodstuffs have been identified, by using different methods and using a protocol to prepare appropriate samples that are not harmful to human health **(Ntrallou *et al.,* 2020).**

Beetroot (*Beta vulgaris* L.) is high in sugar but very low in calories. It also contains large amounts of antioxidants and nutrients, vitamin C, and betaline. The dark red beetroot roots contain active compounds such as carotenoids, saponins, betanins, betanins, polyphenols, and flavonoids. Therefore, eating beetroot is an important factor because it prevents the proliferation of cancer cells and thus protects humanity from cancer. Beetroot is used in bakery products, sweets, ice cream, and more, etc (**Neha *et al.,* 2018).**

The consumer direction has shifted to healthy foods that contain natural dietary fibers and natural colorants that act as natural antioxidants, minerals, vitamins, low calories, low fats, and no artificial color additives. Therefore, carrot juice was used to produce a gelatinous candy that is rich in nutrients with functional properties such as beta-carotene, which gives innumerable nutritional benefits to consumers **(Achumi *et al.,* 2018).**

Nutritional disorders that cause anemia or iron deficiency. Thus, the consumption of vegetables such as spinach which contain high amounts of iron meets the requirements of consumers. For the reason that iron is easily absorbed in the presence of vitamin C. (**Yudhistira *et al.,* 2017).**

Food waste has emerged as one of the primes issues in the Gulf Countries including Saudi Arabia since this region lacks agricultural resources and water Food waste is an environmental problem that causes global climate change **(Aziz, 2012).** For this reason, there is an economic problem that makes them increasingly dependent on imports. This measure states that food waste affects the following categories of environmental sustainability, economics, and social issues, and is therefore also seen as a critical issue within the Sustainable Development Goals (SDGs, sub-goal 12.3) issued by the United Nations in 2015 **(United Nations, 2014).**

The aim of this investigation was achieved to evaluate the food industrial waste as beet peels, carrot peels, and spinach stems. Moreover, extractions of their waste to give colors were used in the manufacture of jelly candy which has high physical properties and nutritional value for a child.

2. MATERIALS AND METHODS

Materials

Beetroot peels (*Beta vulgaris* L.), carrot peels (*Daucuscarota* L.), and green spinach stems(*Amaranthus tricolor* L.) were obtained from the fresh juice store in Taif University, Saudi Arabia, (Female Section), where it was their collected, and soaked in saline to sterilize it.

The ingredients used in the jelly candy prepared were sucrose, glucose syrup, high methoxylation pectin (Degree of esterification 58%), and Glucono Delta-Lactone (GDL), starch mold was obtained from the Local Market in Saudi Arabia.

Folin–Ciocalteau reagents, Gallic acid, Quercetin, DPPH· (2, 2-diphenyl-1- picrylhydrazyl), and BHT: Butyl Hydroxytoluene were purchased from Sigma Chemical Co.(St. Louis, MO, USA).

Methods

Extracts color from carrot peels, beetroot peels, and spinach stems

Carrot peels, beetroot peels, and spinach stems were cut into smaller pieces. A weighed amount of each carrot peels, beetroot peels, and spinach stems was extracted with distilled water in a beaker by 1:20 w/v. The extraction was performed for approximately 60 min at 95◦C and filtered. Two repetitions of extraction were performed. Extracts from carrot peels, beetroot peels, and spinach stem were adjusted at concentrate 15°Brix.

Determination of minerals content of each juice extract

Minerals content as calcium, phosphorus, iron, manganese, was determined in each extract according to the method of the **AOAC (2012),** using Atomic Absorption Spectrophotometer (Perkin Elmer, Model 3300, Germany). While sodium and potassium contents were determined by Flame Photometer (CORNING 400, serial No. 4889.UK).

Determination of vitamins content of each juice extract

Vitamin E (α-tocopherol) was measured by using the high-pressure liquid chromatography (HPLC) method described by **Leth and Sondergaro (1983)**.

The vitamin C content of each extract was determined using ascorbic acid (0.01 mg/mL) as the reference compound. Two hundred milliliters of the extract was mixed with 300 mL of 13.3% trichloroacetic acid (TCA) and 75 mL of 2,4-dinitrophenylhydrazine (DNPH). The mixture was incubated at 37 °C for 3 h and 500 mL of H2SO4 was added to the mixture before the absorbance was read at 520 nm according to **Benderitter*et al.* (1998).**

Total phenolic content of each juice extract

The total phenolic (TP) from carrot peels, beetroot peels, and spinach stems extracts with aqueous, ethanol, methanol, and acetone extract were spectrophotometrically determined by Folin Ciocalteu reagent assay using gallic acid as standard according to **Qawasmeh *et al.* (2012).** The absorbance was determined at 750 nm using a spectrophotometer (Unicum UV 300). The total phenolic content in the samples was expressed as mg gallic acid equivalents (GAE)/ g dry weight sample. All samples were analyzed in triplicates.

Total flavonoids content of each juice extract

Total flavonoids (TF) from carrot peels, beetroot peels, and spinach stems extracts with aqueous, ethanol, methanol, and acetone extract were spectrophotometrically determined by the aluminum chloride method using quercetin as a standard according to **Eghdami and Sadeghi (2010).** The absorbance was measured against blank at 510 nm by using a spectrophotometer (Unicum UV 300). Total flavonoids in the sample were expressed as mg quercetin equivalents (QE)/ g dry weight. All samples were analyzed in triplicates.

Antioxidant activity

DPPH· Free radical scavenging assay of each juice extract

Determination of DPPH • free radical scavenging activity was measured in carrot peels, beetroot peels, and spinach stems extract according to **Ravichandran *et al.* (2012**). The mixture was shaken vigorously and allowed to stand at room temperature. Butyl Hydroxytoluene (BHT, Sigma) was used as positive control while the negative control is contained the entire reaction reagent except for the extracts. Then the absorbance was measured at 515 nm against a blank.

The capacity to scavenge the DPPH • radical was calculated using the following equation:

DPPH • scavenging effect (Inhibition %) = [(Ac – As / Ac) × 100]

Where: Ac is the absorbance of the control reaction.

As is the absorbance in the presence of the plant extracts

Preparation of jelly candies of each juice extract from carrot peels, beetroot peels, and spinach stem:

Jelly candy was prepared according to **Walkenström *et al.* (2003)** and modified with **Avelar and Efraim, (2020)** as following, dissolution of sucrose, glucose syrup, and added separately the extracts from carrot peels, beetroot peels, and spinach stems at level 10 ml extract plus 20 ml water, 20ml extract plus 10ml water and 30 ml from each extract. Also, pectin was added to each solution, and dissolution of Glucono-Delta Lactone (GDL) to acidify the system, finely, deposition of the final candy syrup in starch molds. The ingredients are cooked at a temperature of 140°-180° C. for less than about one minute. After cooking, the hot liquid mixture is deposited into a starch mold. The starch mold forms the confection and helps to reduce the moisture content. The deposited confections are then routinely dried in an oven at 35°C/72 h to give three jelly candies made from carrot peels, beetroot peels, and spinach stems juice. Meanwhile, the jelly candy control was prepared at the same method but it was substituted for each juice with 30 ml water.

Sensory properties in different jelly candies:

The sensory study was conducted to access the consumer preference for jelly candies from carrots, beetroot, and spinach juice. The attributes of the jelly candies set were taste, appearance, sourness, mouthfeel, and overall acceptability. The samples were coded with 3 digits random coding and a 9-point hedonic scale was used for the sensory ratings according to **Yee and Wah, (2017)**.

Proximate color in different jelly candies:

The color *(L*, a*,* and *b** values) of the different jelly candies was measured using Hunter Lab Color Flex EZ colorimeter (Hunter Associates Laboratory, Virginia, The USA). The L* value represents the lightness of the sample where a low number (0 – 50) indicates dark and a high number (51 – 100) indicates light. The value *a** represents red vs. green, where a positive number represents red and a negative number represents green. The *b** value represents yellow vs. blue, where a positive number represents yellow and a negative number represents blue as defined by **Choudhury (2014).** The colorimeter was calibrated with standard black tile and white tile before sample analysis. Different jelly candies were placed and cover the bottom part of the glass optical cell, and then the glass optical cell was placed on the reflectance port to read.

Texture profile parameters in different jelly candies:

The texture profile analysis (TPA) indices of extrusion different jelly candies were determined using a texture analyzer (Cometech, B type, Taiwan) following method for jelly candies according to **Mutlu *et al.* (2018).** The conditions of texture analyzer were provided with software, 35 mm diameter compression disc was used. Two cycles were applied at a constant crosshead velocity of 1 mm/s, to 30% of sample depth and then returned. The parameters measured were the following: hardness (H), adhesiveness (A), springiness (S), cohesiveness (Co), gumminess (G), and chewiness (Ch).

Statistical analysis:

The data obtained in the present study were analyzed by ANOVA. For all analyses, when a significant difference ($p \leq 0.05$) was detected in some variable, the data means test was applied to evaluate the difference between the samples. The results were analyzed with the aid of the software SAS System for Windows **SAS (2008).**

3. RESULTS AND DISCUSSION

Minerals content and vitamins of each juice extract from raw materials

The results from Table (1) showed that the minerals content as potassium and sodium in the carrot peel were the highest by 320.0 and 69.0 mg/100g dry weight, followed by phosphorus, calcium, and manganese were 35.0, 33.0, and 12.0mg/100g dry weight, respectively. An iron mineral was the lowest (0.3 mg/100g) than other minerals. Moreover, vitamins C and E were determined in carrot peel and the results reported that the vitamins had contained 5.90 and 0.66 mg/100 dry weight, respectively. These results are confirmed with **Sharma *et al.* (2012)** who found that the minerals content of carrot peel was Ca, Fe, P, Na, K, Mg, Cu, Zn (34.0, 0.4, 25.0, 40.0, 240.0, 9.0, 0.02, 0.2 mg/ 100 g). Moreover, carotenes, thiamine, riboflavin, niacin, and vitamin C which had contained 5.33, 0.04, 0.02, 0.2, and 4.0 mg/100 g, and energy value (126 kJ/100 g).

The results of minerals content from beetroot peels indicated that the major minerals were potassium, phosphorus and calcium contained 325.0, 66.0, and 48.0 mg/100 dry weights. The minor metals in beetroot peels were sodium and manganese contained 27.0 and 25.0 mg/100g dry weight. An iron mineral was the lowest (0.27mg/100g) than other minerals. Moreover, vitamins C and E were determined in beetroot peels and the results illustrated that the vitamins had contained 93.0 and 1.42 mg/100 dry weight, respectively. These results are confirmed with **Diego dos *et al.* (2017)** who considered that beetroot *Beta vulgaris* L. contains dietary fiber, minerals, vitamins, antioxidants, betalains, and phenolic compounds, and has high nutritional value due to its high content of glucose, in the form of sucrose.

The results of the minerals content from spinach stems in the same table reported that the spinach stems had the highest minerals like potassium, calcium, sodium, manganese, phosphorus, and iron were 558, 99.0, 79.0, 75.0, 49.0and 2.70 mg/100g dry weight, respectively. Furthermore, vitamins C and E were determined in beetroot peels and the results illustrated that the vitamins had contained 28.0 and 2.03 mg/100 dry weights, respectively. The inorganic matrix in both leaves and stems of spinach is primarily comprised of Na, K, Mg, and Ca. Phosphorous comes next in terms of significance. It may be noted that both leaves and stems contain an appreciable amount of Al. Spinach leaves and stems also contain a significant amount of Fe. However, it is interesting to note that the occurrence of Fe is usually associated with trace occurrence of Mn and Zn (**Bhattacharjee *et al.,* 1998).**

Table 1: Minerals and vitamins content of each juice extract from raw material on dry weight mg/100g

Minerals and vitamins content	Carrot extract	Beetroot extract	Spinach extract
Calcium	33.0±0.94	48.0±0.75	99.0±1.24
Phosphorus	35.0±0.86	66.0±0.62	49.0±0.83
Manganese	12.0±0.21	25.0±0.17	79.0±0.62
Iron	0.30±0.01	0.27±0.04	2.70±0.01
Potassium	320.0±9.12	325.0±9.38	558.0±12.35
Sodium	69.0±0.84	27.0±0.24	79.0±0.94
Vitamin C	5.90±0.07	93.0±1.25	28.0±0.18
Vitamin E	0.66±0.01	1.45±0.01	2.03±0.01

Values are mean and SD (n = 3)

Total phenolic and total flavonoids of each juice extract:

Table (2) showed that the determination of total phenolic and flavonoids in different extracts and the results noticed that the total phenolic acids in carrot peels, beetroot peels, and spinach stem at methanol extract were the highest in beetroot extract by 35.76 mg/g GAE followed was carrot and spinach were 31.68 and 25.19 mg/g GAE, respectively. After that ethanol extract showed the total phenolic acids were 25.53, 22.28, and 18.38 mg/g GAE from beetroot, carrot, and spinach extract, respectively, followed by acetone extract was22.89, 20.57, and 15.69 mg/g GAE, respectively. Whilst, aqueous extract for raw materials extract was the lowest. These results confirmed by **Lapornik *et al.,* (2005)** noticed that the methanol extract had contained high amounts from phenolic acids and flavonoids compounds, for the reason that it can set free the cell wall-bound polyphenol from the cells and equalize the activity of polyphenol oxidase (PPO) which degrades the polyphenol in plants. This study confirmed with **Turkmen *et al.,* (2006)** reported that the solvent with high polarity has extracted a great content of polyphenols and its antioxidant activity.

Table 2: Total phenolic acids and flavonoids compounds of extract from raw materials

Solvents	Total phenolic acids mg/g GAE			Total flavonoids compounds mg/g QE		
	Carrot extract	Beetroot extract	Spinach extract	Carrot extract	Beetroot extract	Spinach extract
Aqueous	8.26±0.09 [c]	10.23±0.15[c]	7.31±0.05 [c]	7.07±0.04 [c]	7.98±0.14[c]	5.16±0.01 [c]
Ethanol	22.28±0.13[ab]	25.53±0.39[ab]	18.38±0.24[ab]	15.28±0.12[ab]	17.67±0.38[ab]	13.28±0.25[ab]
Methanol	31.68±0.64[a]	35.76.±0.30[a]	25.19±0.28 [a]	22.19±0.26 [a]	27.24±0.35[a]	17.39±0.28 [a]
Acetone	20.57±0.17 [b]	22.89±0.15 [b]	15.69±0.11 [b]	10.18±0.08 [b]	13.68±0.22 [b]	8.29±0.05 [b]

Values are mean and SD (n = 3); where: Mean values in the same with the letter are significantly different at p<0.05 levels.

Total flavonoids compounds from the same table indicated that the highest amounts were in beetroot methanol extract by 27.35 mg/g QE followed by carrot and spinach were 22.19 and 17.39 mg/g QE, respectively. Furthermore, for ethanol and acetone extract for carrot, beetroot, and spinach, the results were parallel to the above results from total phenolic acids, and also, the aqueous extract was the lowest than other extracts.

Phenolic compounds are secondary metabolites produced in plants and contained phenolic acids and flavonoids compounds **(Manach *et al.,* 2004).** They are treated to more health-encourage influence which acts as an antioxidant and thereby it was therapy for more diseases, such as cancer, lowering blood glucose, and cardiovascular **(Huang and Shen, 2012).**

DPPH scavenging activity of each juice extract

The results in Table (3), observed that greater DPPH scavenging activity at a concentration of 50µg/ml in methanol extract. Moreover, the results which high activity was obtained from beetroot with methanol, ethanol, and acetone extracts by 55.28, 45.31, and 40.41%, respectively, followed by carrot extract was 40.45, 35.01 and30.82% and spinach was 37.10, 28.36 and 24.59%, respectively. Furthermore, the IC50 values in methanol extract were the highest in beetroot by 39.59µg/ml, followed by carrot and spinach were55.29 and 60.76µg/ml, respectively, compared to BHT was 25.53µg/ml. Also, for ethanol and acetone extract for carrot, beetroot, and spinach, the results were parallel to the above results from total flavonoid compounds, and also, the aqueous extract was the lowest than other extracts. It is best to refer that a less IC50 value appears to stronger free radical inhibitory activity. Therefore, the found results point out that methanol, ethanol, and acetone extracts having great power antioxidant activity than aqueous extract. This means that the strong antioxidative properties of these extracts, it could be caused to the presence of various antioxidant components (**Mrvcic *et al.,* 2012).** Furthermore, **Sultana *et al.,* (2007)** noticed that greater activity of DPPH・ radical scavenging activity has contained high levels of total phenolic and flavonoids which scavengers, acting possibly as elementary antioxidants and serve as free radical inhibitors.

Generally, these results showed that the carrot; beetroot, and spinach wastes can be used for foodstuff, which had contained high amounts from antioxidant components as well as also utilized for value to increase in nutritional ingredients. Therefore, these results are attributed to the utilization of the wastes in the food industry (**Shyamala and Jamuna, 2010).**

Table 3: DPPH· scavenging activity of extract from raw materials

Solvents	Scavenging activity %					
	Carrot extract		Beetroot extract		Spinach extract	
	50µg/ml	IC_{50} µg/ml	50µg/ml	IC_{50} µg/ml	50µg/ml	IC_{50} µg/ml
Aqueous	25.40±0.34[d]	92.24±3.14[a]	30.18±0.81 [d]	87.32±3.79 [a]	15.13±0.14 [d]	97.25±4.25[a]
Ethanol	35.01±0.29[bc]	65.21±1.38[c]	45.31±0.75[bc]	53.86±1.44[c]	28.36±0.21[bc]	75.68±3.67[c]
Methanol	40.45±0.31 [b]	55.29±1.87[d]	55.28±0.53[c]	39.59±0.51[d]	37.10±0.23 [b]	60.76±2.14[d]
Acetone	30.82±0.28 [c]	80.27±2.13[b]	40.41±0.82[b]	59.76±0.46[b]	24.59±0.27[c]	85.26±3.12[b]
BHT as standard	70.32±1.28 [a]	25.53±0.27[e]	70.32±1.28 [a]	25.53±0.27[e]	70.32±1.28 [a]	25.53±0.27[e]

Values are mean and SD (n = 3); where: Mean values in the same with the letter ±are significantly different at p<0.05 levels

Sensory properties of jelly candies from each juice extract

Consumers are keep away from foods that had contained artificial pigments, thus, it can be used the natural color as an alternative synthetic pigment in food industries. Therefore, the pigments are extracted from the plant material as vegetables and fruits, and their waste **(Aberoumand, 2011).**

Table (4) estimated that the results of the various sensory properties, for the different jelly candies made from carrot, beetroot, and spinach at levels 10.0, 20.0, and 30.0ml juice compared with control without juice but with 30ml water. The results confirmed that the beetroot jelly candy was set to be the most appreciated jelly samples with a significantly higher score in all sensory attributes followed by carrot and spinach jelly candies. Therefore, it could be recommended to use beetroot, carrot, and spinach juice by 30ml to improve the sensory quality of jelly candies by natural color for children. The highest ratings for the taste, particularly in samples 30ml beetroot, carrot, and spinach content, maybe due to the higher in betalains, beta carotene, and chlorophyll. Certainly, the shining orange pigment is greater attractive than the chlorophyll green pigment of spinach. Therefore, a greater advantage for the shining orange color than the green color

(**Zinoviadou *et al.,* 2015).** Moreover, the red beetroot is known to be a powerful antioxidant where it contains a group of phenolic compounds called betalains which are water-soluble pigments and responsible for the intense red color of red beetroots **(Wruss *et al.,* 2015).** Therefore, it could be used as sources of natural colorants in many fields of the food industry **Chranioti *et al.* (2015),** where it was used to enhance the color of soy/carrot juices **(Banigo *et al.,* 2015),** improving the red color of more food products and breakfast cereals **(Roy *et al.,* 2004).**

Table 4: Sensory properties of jelly candies at a different level from raw materials

Samples	Taste	Appearance	Aroma	Mouthfeel	Overall acceptability
Control	6.0±0.21 c	5.0±0.01 d	5.0±0.02d	6.0±0.16 c	5.25±0.08 d
Carrot juice					
10 ml	7.0±0.32 b	6.0±0.18 c	6.0±0.17 c	6.0±0.14 c	6.25±0.16 c
20 ml	7.5±0.35 b	7.0±0.23 b	7.0±0.19 b	7.0±0.27 b	7.13±0.13 b
30 ml	8.0±0.28 a	8.0±0.34 a	8.0±0.25 a	8.0±0.36 a	8.0±0.24 a
Beetroot juice					
10 ml	7.5±0.34 b	7.0±0.28 b	7.0±0.19 b	7.0±0.15 b	7.16±0.15 b
20 ml	8.0±0.16 a	7.5±0.24 b	7.5±0.15 b	7.5±0.19 b	7.63±0.16 b
30 ml	8.5±0.36a	8.5±0.32 a	8.0±0.16 a	8.0±0.27 a	8.25±0.28 a
Spinach juice					
10 ml	6.0±0.14 c	6.0±0.11 c	6.0±0.13 c	6.0±0.13 c	6.0±0.13 c
20 ml	6.5±0.12c	6.5±0.12 c	6.5±0.2 c	6.5±0.17 c	6.5±0.21 c
30 ml	7.0±0.31b	7.0±0.24 b	7.0±0.22 b	7.0±024 b	7.0±0.24b

Values are mean and SD (n = 3); where: Mean values in the same with the letter ±are significantly different at p<0.05 levels

Color in different jelly candies from each juice extract

Colors are indicators that appear the consumer's acceptance of foods; therefore, synthetic colorant marketing has lowered in favor of natural colorants **(Fletcher, 2006)**.

The color parameters of different jelly candies at levels 10.0, 20.0, and 30.0ml from carrot, beetroot, and spinach juice were characteristic and the results are tabulated in Table (5). From the results, it could be noticed that the decrease in $L*$ values of jelly candies from 60.67 to 40.31 to beetroot candy followed by carrot candy from 55.68 to 37.38 and spinach was the lowest from 50.23 to 35.96, respectively, than control candy was 60.25, these means low luminosity and brightness. Values $a*$ of control jelly candies were 2.93 and those of beetroot were significant increased from 0.6.53 to 9.59, followed by carrot and spinach jelly candies. There was an increase in $a*$ and a decrease in $L*$ value when the increasing of coloring pigments. The $b*$ value of control jelly candies was 8.37 and jelly candies with various concentrations of spinach significantly increased from 14.17 to 18.25 followed by carrot jelly candy was from 13.21 to 16.76 and beetroot was the lowest from 12.35 to 15.62, respectively. the color variations of different jelly candies for the increase in $b*$ value can be demonstrated by the degradation of pigment that reasons the formation of a yellow degradation product, in addition to the formation of the brown compound (**Kaimainen *et al*., 2015).** Moreover, a lowering in lightness may be caused by has changed the color of brown. Meanwhile, the redness ($a*$) has remained stable throughout eight weeks during the storage period, thus exhibiting better color retention **(Esquivel, 2016).**

Plant natural pigments are widely used as alternatives not only because of their high availability as a coloring agent but also exhibit an abundance of health-promoting values such as antioxidants and antimicrobial activity which favor human beings **(Mohd-Nasir et al., 2018).**

Table 5: Color parameters of different jelly candies

Sample	$L*$	$a*$	$b*$
Control	65.25±4.38a	2.93±0.14e	8.37±0.73e
Carrot juice			
10 ml	55.68±3.28	4.39±0.28 d	13.21±0.83d
20 ml	47.39±2.76d	6.92±0.36 c	15.38±1.93
30 ml	37.38±1.28 e	7.13±0.39b	16.76±1.25b
Beetroot juice			
10 ml	60.67±4.27b	6.53±0.24 c	12.35±0.94
20 ml	52.29±3.51 c	8.26±0.49ab	14.46±1.61c
30 ml	40.31±2.38 d	9.59±0.76a	15.62±1.27bc
Spinach juice			
10 ml	50.23±3.41c	4.05±0.26d	14.17±1.26 c

20 ml	42.28±2.83^{d}	5.00±0.43^{bc}	17.39±1.39^{ab}
30 ml	35.96±1.64^{e}	6.39±0.39^{c}	18.25±1.71^{a}

Values are mean and SD (n = 3); where: Mean values in the same with the letter ±are significantly different at p<0.05 levels

Texture profile in different jelly candies from each juice extract

Table (6) observed that the results from texture parameters were determined in jelly candies made from carrot, beetroot, and spinach juice at level 10.0, 20.0, and 30.0ml from each juice. The hardness of the jelly candy prepared using the beetroot juice was 14.31, 15.18, and 16.29 N, respectively at level 110.0, 20.0, and 30.0ml followed by carrot and spinach jelly candies than control jelly candy at 30ml water was 12.78 N. Hardness, also known as firmness, is the most significant sensorial parameter for TPA analysis. It is a factor that is used to evaluate the mouthfeel and is defined as the force required to attain a given deformation **(Garrido *et al.,* 2014).** Candies with a small-scale firmness and high springiness have a good chewiness property **(Kek *et al.,* 2013).**

Adhesiveness (also known as stickiness) indicates the work required to control the attractive power between the surface of both food and the material **(Mutlu *et al.,* 2018).** The adhesiveness for the control jelly candy was 0.25 Ns^{-1} whilst, the beetroot ranged from 0.31 to 0.45 Ns^{-1} followed by carrot ranged from 0.29 to 0.43 $Ns^{-1,}$ and spinach was from 0.27 to 0.40 Ns^{-1}, respectively. These values depend on the surface properties and the combined effect of adhesive and cohesive forces **(Hamedi *et al.,* 2018)** which are related to the molecular structure of the products **(Mutlu *et al.,* 2018).** Studies have shown that jellies with high-scale firmness also have a high value of adhesiveness **(Mutlu *et al.,* 2018).**

The jelly is easy to chew and swallow when it has a low cohesiveness value. In the real world, cohesiveness is the most important parameter for the acceptance factors for all ages **(Kawano *et al.,* 2017).** Both of the jelly candies possess a similar cohesiveness value from 0.82 to 0.88. In contrast to the hardness, the cohesiveness decreases with the increase in Juice concentration **(Garrido *et al.,* 2014).**

The springiness of food is inversely proportional to hardness (firmness increases, elasticity decreases) **(Kreungngern and Chaikham, 2016).** Table (6) also known as elasticity, springiness represents the rate at which the deformed sample returns to its initial condition after the removal of the deforming force **(Garrido *et al.,* 2014).** The results from beetroot were ranged from 0.93 to 1.43 mm followed by carrot candy ranged from 0.92 to 1.23 mm and spinach candy was ranged from 0.91 to 1.12 mm, respectively. A previous study has shown that the springiness of jelly candy is between 0.90-1.50 **(Khouryieh *et al.,* 2005).**

Table 6: Texture profile measurements in different jelly candies

Samples	Hardness (N)	Adhesiveness (Ns^{-1})	Springiness (mm)	Cohesiveness	Gumminess (N)	Chewiness (N mm)
Control	12.78±0.12^{e}	0.25±0.01^{c}	0.90±0.12^{e}	0.89±0.11^{a}	11.38±0.23^{e}	87.39±4.28^{e}
Carrot juice						
10 ml	13.12±0.17^{d}	0.29±0.2^{c}	0.92±0.04^{d}	0.87±0.04^{ab}	12.24±0.42^{d}	91.29±5.21^{d}
20 ml	14.28±0.21^{b}	0.35±0.2^{b}	0.98±0.07^{c}	0.85±0.07^{b}	13.38±0.35^{c}	93.43±5.38^{c}
30 ml	1519±0.24^{b}	0.43±0.3^{a}	1.23±0.38^{ab}	0.82±0.03^{bc}	14.52±0.41^{b}	95.49±6.02^{b}
Beetroot juice						
10 ml	14.31±0.26^{b}	0.31±0.3^{b}	0.93±0.29^{d}	0.86±0.02^{ab}	13.64±0.51^{c}	93.64±4.67^{d}
20 ml	15.18±0.28^{b}	0.39±0.3^{b}	1.15±0.27^{ab}	0.84±0.04^{bc}	14.51±0.49^{b}	95.72±5.39^{b}
30 ml	16.29±0.31^{a}	0.45±0.04^{a}	1.43±0.48^{a}	0.80±0.03^{c}	15.42±0.62^{a}	97.81±6.18^{a}
Spinach juice						
10 ml	12.81±0.15^{e}	0.27±0.01^{c}	0.91±0.24^{e}	0.88±0.05^{a}	11.94±0.28^{e}	89.23±3.68^{e}
20 ml	13.94±0.12^{d}	0.32±0.02^{b}	0.93±0.06^{d}	0.86±0.02^{ab}	12.83±0.29^{c}	91.38±4.19^{d}
30 ml	14.86±0.14^{c}	0.40±0.03^{a}	1.12±0.28^{b}	0.83±0.06^{bc}	13.91±0.31^{c}	93.28±5.08^{c}

Values are mean and SD (n = 3); where: Mean values in the same with the letter ±are significantly different at p<0.05 levels

A secondary parameter, gumminess, was calculated as the product of hardness time's cohesiveness. The studies showed that the gumminess of a product increases when hardness increases **(Mutlu *et al.,* 2018)** because the energy needed to disintegrate a semi-solid food product to a state ready for swallowing increases when the jelly is harder **(Kreungngern and Chaikham, 2016).** Gumminess for the jelly candy prepared with beetroot was ranged from 13.64 to 15.42 N which is higher than carrot jelly candy was12.24 to 14.52N and 11.94 to 13.91 N, respectively, recorded for the control jelly candy was 11.38N.

The results from chewiness indicated that decrease when increasing concentrations from beetroot, carrot, and spinach juice to prepare jelly candies. Chewiness is one of the important texture characteristics of a jelly product **(Calvarro *et al.,* 2016).** Similar to gumminess, chewiness will increase if the degree of hardness increases **(Mutlu *et al.,* 2018).**

4. CONCLUSION

The agro-food industries produce great amounts of fruit and vegetable waste, which opens the way to administering this waste efficiently. But these wastes are still unexploited, even though they contain health-beneficial substances such as dietary fiber, a natural antioxidant, and color. Therefore, it suggests a ''Stop Wasting Food and utilization of the food industrial waste" therefore should be started. It could be recommended to activate the role of extension education show that the utilization from food- industrial waste in the KSA through programs offer that the importance the waste for food-industrial.

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