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UTLIZATION OF FRUIT AND VEGETABLE WASTE POWDERS FOR FORTIFICATION OF SOME FOOD PRODUCTS

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ABSTRACT: This study was carried out to evaluate the chemical, physical and sensory properties of supplemented crackers and fortified yoghurt with fruit and vegetable waste powders. Prickly pear's peel (PPP), cantaloupe peel (CP), peas peel (PP) and cabbage stalks and outer leaves waste (CLS) have been used. Wheat flour of crackers was supplemented by 3, 5 and 7% of these waste powders. Yoghurt was fortified with PPP and CP powders at levels of 1.5 and 2.5%. Results showed that PPP powder was the highest in fat content (18.66%), while PP powder was rich in protein and carbohydrates (19.52 and 50.29%), respectively and CLS powder had the highest content of fibers (39.46%). CP powder had higher water holding capacity (WHC) comparing with other wastes. Moreover; CLS powder had the highest values of mostly all physical characteristics. It was noticed that along with waste powders adding; an increase in chemical composition occurred in both food products. Supplementation with waste powders affected colour values; both PP and CLS made crackers tend to be greenish colour. Fortified yoghurt became more yellow and brighter. Sensory evaluation illustrated that 7% CP crackers gained the highest sensory scores; even more than control samples. In conclusion; it is recommended to add 7% CP powder to crackers and 1.5% CP powder to yoghurt in order to achieve the best results.

Key words: Dietary fibers, prickly pear's peel, cantaloupe peels, peas peel, leaves and stalks of cabbage, crackers, yoghurt, chemical composition, sensory evaluation.

INTRODUCTION

Processing of fruits and vegetables are resulting in high amounts of by-products such as peels, seeds, stones, meals *etc*. It is well known that agroindustrial by-products are rich in dietary fibers (DF), some of which contain appreciable amounts of colorants, antioxidant compounds or other substances with positive health effects (Vasso and Constantina, 2007). Some major source of food peels are prickly pears (*Opuntia ficus indica*), cantaloupe (*Cucumis melo* var. cantalupensis), peas (*Pisum sativum*) and cabbage (*Brassica oleracea* var. capitata*)*.

Dietary fibers (DF) first came into existence in 1953 and included cellulose, and hemicelluloses (Mudgil and Sheweta, 2013). It is defined as the edible parts of plants or analogous carbohydrates that are resistance to digestion and adsorption in the human small intestine (AACC, 2001 and 2002). WHO recommends of eating 25- 30 grams per day, according to prescribed calories per person, for children the amount of fiber needed by the child's day is equal to (the child's age + 5) according to (Mudgil and Sheweta, 2013). This amount increases with the child’s age. DF can also impact some functional properties to foods, *e.g.,* increase water holding capacity (WHC) and oil holding capacity (OHC), emulsification and/ or gel formation (Elleuch *et al.,* 2011). Fruit and vegetable wastes; which are represented in a great amounts during industrial processing, creates a serious problem, as they exert an influence on environment and need to be managed and/or utilized. On the other hand, they are very rich in bioactive components, which are

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considered to have beneficial effect on health. For the last decade, efforts have been made to improve methods and ways of re-using these wastes (Duda-Chodak and Tarko, 2007).

Prickly pear belongs to the family Cactaceae, being so water-use efficient, they are highly useful in arid and semiarid environments. So, it is widely distributed in Latin America, South Africa and the Mediterranean area including Egypt (Hassan, 2011). The powder of prickly pear fruit is a good source of sugars, vitamins, minerals, DF and many bioactive compounds; all are valuable components to human health (Mashal, 2016). Prickly pear fruits peels were used successfully as a functional food in many therapeutic and technological applications (Elhassaneen *et al.,* 2016). Cantaloupes are one of the most consumed worldwide because it is nutritive and it has a good flavour and health benefits (Ismail *et al.,* 2010; Mohamed *et al.,* 2013). Among subtropical vegetables, "cantaloupe" is the fourth largest product (produced ≈32 million tons/year) behind orange, banana and grapes (USDA, 2009). Previous studies showed that cantaloupe skin extract possesses high antioxidant and anti-inflammatory properties which attributed to its high content of many bioactive compounds including vitamins, DF, phenolics, carotenoids *etc.* (Vouldoukis *et al.,* 2004; Ibrahim and El-Masry, 2016).

Peas represent a very famous vegetable, the total production was 190.146 tons/year, this results a huge amount of peel, which are so nutritional and a great loss for wasting them (Abd-Alla *et al*., 2016). Peels has insoluble fibers (85.4%) and soluble fibers (14.6%) of DF (Belghith *et al*., 2016). Cabbage belongs to cruciferous family Cruciferae (Brassicaceae). It is an important vegetable in Egypt, Sharkia governorate alone produces about 16.23 tons in the season (Agricultural Statistics, 2014). Cabbage leaves considered as a waste which obtained during processing (pickling and cooking) of cabbage. Huge amount of leaves is generated, and its disposal is a major problem and causes environmental pollution (Ali, 2013), it has been reported that cabbages to contain high amount of DF and high antioxidant activity (Sivarin *et al.,* 2009).

Yoghurt is among the most common dairy products consumed around the world, and its sensory attributes have a large effect on consumer acceptability (FAO/WHO, 2001). Yoghurt has gained a positive perception by consumers as a functional dairy product with health promoting ingredients consequently (Roberfroid, 1993). Bakery products had used dietary fibers from different sources in its preparation (Foschia *et al.,* 2013). Crackers are the popular snack products which have appreciable demand amongst the consumers (Maneerote *et al*., 2009; Sedej *et al*., 2011).

The present study was carried out to investigate the effect of using powders of some fruit and vegetable peels including PPP, CP, PP and CLS in the production of crackers and yoghurt. Effect of this supplementation and fortification on the chemical, physical and sensory properties was also studied.

MATERIALS AND METHODS

Raw Materials

Prickly pears (*Opuntia ficus indica),* cantaloupe (*Cucumis melo* var. cantalupensis), peas (*Pisum sativum*) and cabbage (*Brassica oleracea* var. capitata*)*; were purchased as fruits and vegetables from Al Obour Market, Cairo, Egypt during the seasons 2015-2016. Wheat flour (72% extraction), sugar, margarine, salt, and baker's yeast, were purchased from local markets. Fresh bulk buffalo's milk (3% fat), *Streptococcus thermophilus,* and *Lactobacillus delbrueckii* subsp. *bulgaricus*, as starter cultures were obtained from Dairy Products Unit, Faculty of Agriculture, Zagazig University, Egypt.

Preparation of Waste Powders

Prickly pear and cantaloupe peel powders

The fruits of prickly pears and cantaloupe were carefully washed with running tap water until they were cleaned, and then they were manually peeled. The peels were shredded into small pieces and been collected for steaming for 30 min, air dried for 2 hr. Prickly pear peels were oven drying at 50°C for 72hr. (Habibi *et al.,* 2009), and cantaloupe peel at 55°C for 72 hr. (Al-Sayed and Abd Elrahman, 2013); to a moisture content 8 ±1.54%.

Peas peel and cabbage stalks and outer layers powders

Peas peel and cabbage stalks and outer leaves were carefully washed, then were manually shredded, then steaming for 30 min, air dried for 2 hr. After that it was oven drying at 40°C in peas peel for 48 hr. (Chaari *et al*., 2012) and at 55°C for cabbages for 4 days (Yardfon *et al.,* 2012); to a moisture content 8±1.23%.

All dehydrated fragments were ground by a domestic electric mixer (Kenwood ES slex, USA); in two steps between the first grinding and the second there were two phases sifting in silk sifter, using a cheese cloth. The fine powder were collected in air-tight bags and stored in a deep freezer at-18°C until analysis and use.

Preparation of Crackers

Cracker samples were prepared in a straight dough process according to the recipe of Ahmed and Abozed (2014). All - purpose wheat flour (100 g), sugar (2g), salt (2.5g), bakers' yeast (2g), margarine (2g), and then water was added until the dough is formed and that was the control sample. Wheat flour was replaced by waste powders at levels of 3%, 5%, and 7%. Ingredients were mixed into cohesive dough, rolled into a consistent, and then it was shaped after proofing. The crackers were baked in an air-fanned oven at 210°C for 15 min., then cooled at ambient temperature, and stored in sealed boly-ethyle bags.

Preparation of Yoghurt

Fresh low fat buffalo's milk (3% fat) was divided into 5 equal portions, portion one was used as control(Y), PPP was added to second and third portions at levels of 1.5% and 2.5%, respectively (YP1,YP2). CP was added to fourth and fifth portions at levels of 1.5% and 2.5%, respectively (YC1, YC2). Milk mixes were homogenized by domestic blender (El-Araby Toshiba, Banha, Egypt) and heated to 85°C for 30 min, cooled to 43°C and inoculated with 0.03% starter culture, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus.* Samples were put in 100 g plastic cups and incubated at 43°C in the incubator. After complete coagulation, the resultant products were stored at 4 ± 1°C (Fiszman *et al*., 1999; Ayar *et al*., 2006).

Determination of Chemical Composition

Moisture, protein, fat, ash and fiber contents were determined according to the methods described in AOAC (2012). Carbohydrates were calculated by difference as follows: Carbohydrates = 100 – (moisture + protein + fat + ash + crude fiber %).

Total energy (Kcal/100g) was calculated as: (3.7 × carbohydrates + 4.02 × proteins +9 × fats %) as described by Insel *et al.* (2002).

Physical Characteristics of Waste powders

Bulk density was determined according to Parrott *et al.* (1995). Swelling capacity was measured by the bed volume technique as described by (Kuniak and Marchessault, 1972). Water holding capacity (WHC) was determined as described by Parrott *et al.* (1995), and oil holding capacity (OHC) has been measured according to Collins *et al.* (1982), using corn oil (at the ratio of 50:1 *V/W*) instead of distilled water.

Measurement of Colour

Colour was measured using Hunter optical lab sensor devise (slex. EZ. USA) according to Rao *et al.* (2011). Colour parameter L* indicates degree of lightness, a* indicates degree of redness to greenness and b* indicates degree of yellowness to blueness. The total colour difference (ΔE) was estimated according to Sapers and Douglas (1987).

Sensory Evaluation

Food Sci. staffs sensory evaluated different treatments of crackers for various attributes as (20) for each: colour, taste, crispness, odour, appearance and overall acceptability, as described by Schormuler (1968) and customized by Meilgaard *et al*., (2007). Yoghurt was given marks for taste (45), body texture (35), appearance (10) and acidity (10) (Istelen and Karagul-Yuceer, 2006).

Statistical Analysis

The data were statically analyzed by analysis of variance (Chi² test) the corresponding replicates, using statistical software (SSPS window 20.0, 2014) (Sarhan, 2014).

RESULTS AND DISCUSSION

Chemical Composition of Waste Powders

Results in Table 1 indicate that the chemical composition of waste powders (on dry weight basis). From such results it could be noticed that PP powder had the highest moisture, protein and carbohydrate contents (11.43%, 19.52% and 50.29%), respectively, while prickly pear peel powder (PPP) had the lowest moisture value (7.88%). In this direction, Lahsasni *et al*. (2004) registered that moisture of PPP powder was 5.97%. The lowest protein content was 3.35% in CLS powder. The highest fat content was (18.66%) in PPP, and the lowest fat value was found in PP powder (1.29%). CP powder had the highest ash content (16.67%). The lowest ash value was (4.37%) for CLS powders. CLS have the highest crude fiber value (39.46%) and PPP had the lowest value (11.69%).

Physical Properties of Waste Powders

Bulk density expressed as g/ml, is an important character as it reflects the behavior of a materials in dry mixes as well as volume occupied during packing (Ibrahem *et al.,* 2013). Results in Table 2 show the physical properties of waste powders. There was slight differences in bulk density between PPP and CP (0.51 and 0.49 g/ml), while the highest value was found in CLS (0.77 g/ml). Swelling capacity indicates how much the fiber matrix swells when water absorbed. Table 2 represented that CLS had the highest value (7.7 ml/g) followed by CP then, PPP and the lowest value was (3.1 ml/g) for PP. Water holding capacity (WHC) is the amount of water that is retained by known weight of dry fibers under specified conditions of temperature, time soaked, and duration and speed of centrifugation (Fleury and Lahaye, 1991). In general, the polysaccharide constituents of DF are strongly hydrophilic. Table 2 illustrates that PPP powder had the lowest value (2.13 ml H_2O/g), there were a slight difference in WHC between CP powder and CLS powder (7.7 and 7.3 ml H_2O/g). PP powder had a similar value as described by Belghith *et al*. (2016) in both WHC and OHC. The highest OHC was 3.12 ml oil /g in PPP powder and the lowest was (1.59 ml oil/g) for CLS powder. The results gave a clear idea that CP powder was higher in WHC but CLS powder had the highest values of mostly all physical characterizes.

That gives an indicator that CLS powder is good substitution source and had all technological properties.

Chemical Composition of Crackers Supplemented with Waste Powders

Crackers are low-moisture content products that have a unique crispy texture. In commercial production of saltine crackers, flour of low water absorption but relatively strong gluten strength is required (Kweon *et al*., 2011). Table 3 demonstrated chemical composition of supplemented crackers. PP crackers had the less moisture content among the other supplemented crackers. It is overuse that C (control crackers) had the lowest moisture percent (4.31%). A very high significant different ($P \leq 0.001$) was found between moisture in C and supplemented crackers. PP crackers (Ps3) had the highest moisture value (11.06%). Moisture content decreases along with more supplementing; that may be caused due to the moisture content for each waste powder and it's WHC.

Concerning fat content, the highest value was (6.43%) for PPP crackers (Pr3), while PP crackers (Ps1) had the lowest percent (2.02%). There were significant correlations ($P \leq 0.05$) between fat in C and PPP crackers (Pr1, Pr2 and Pr3), CP crackers (Cn1, Cn2 and Cn3), but no differences were found in PP crackers (Ps1, Ps2 and Ps3), and CLS crackers (Cb1, Cb2 andCb3). PP was a low fat component according to Belghith *et al*. (2016) who proved that adding this DF powder to bread decreased fat in bread but gave it a high WHC, OHC which provide it with a long shelf life. The highest carbohydrate content (76.51%) was found in C, it was noticed that with more peel powder added to the supplemented crackers; a decrease in carbohydrates values were occurred, except in CP crackers; there carbohydrate values began to increase with more supplementation (69.37, 70.06 and 70.82% for Cn1, Cn2 and Cn3, respectively). This result according to CP were agree to Al-Sayed and Abd El-Rahman (2013) who illustrated that, adding CP to cake increased carbohydrate's content by more substitution.

Table 1. Chemical composition of waste powders

Component (%)	Fruit peel powder		Vegetable waste powder	
	PPP	CP	PP	CLS
Moisture	7.88±1.78d	8.22±1.32c	11.43±0.15a	9.26±2.37b
Protein (on DM)	13.48±1.46c	3.35±1.54d	19.52±0.42a	14.64±0.06b
Fat (on DM)	18.66±0.31a	1.45±0.24b	1.29±0.12d	1.34±0.06c
Ash (on DM)	16.38±0.32b	16.67±2.11a	4.45±0.24c	4.37±0.31d
Crude fiber (on DM)	11.69±1.22d	27.44±3.01b	13.08±1.71c	39.46±4.08a
Carbohydrate(on DM)	31.91±3.34c	42.87±4.87b	50.29 ± 1.75a	30.93±4.85d

Means a, b, c, d within a raw with different superscript are significantly different. PPP: Prickly pear peel powder CP: Cantaloupe peel powder PP: Peas peel powder CLS: Cabbage outer leaves and stalks powder.

Table 2. Physical properties of waste powders

Parameter	Fruit peel powder		Vegetables waste powder	
	PPP	CP	PP	CLS
Bulk density (g/ml)	0.51±0.14c	0.49±0.01d	0.62±0.02b	0.77±0.03a
Swelling capacity (ml/g)	3.5±0.09c	3.9±1.0b	3.1±0.08d	4.1±1.021a
Water holding capacity (ml H_2O/g)	2.13±0.84d	7.7±1.58a	4.65±0.98c	7.3±1.26b
Oil holding capacity (ml Oil/g)	3.12±1.04a	2.24±1.32c	2.86±0.43b	1.59±0.81d

Means a, b, c, d within a raw with different superscript are significantly different. PPP: Prickly pear peel powder CP: Cantaloupe peel powder PP: Peas peel powder CLS: Cabbage outer leaves and stalks powder.

Table 3. Chemical composition of crackers supplemented with waste powders

Component Cracker	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)	Total Energy (Kcal/ 100g)
C	4.31±0.68f	10.27±0.95f	3.14±0.45d	2.41±0.18a	3.36±0.49d	76.51±1.45a	375.38±1.03a
Pr1	7.98±0.85d	13.31±1.02f	6.16±0.42a	1.65±0.13b	3.39±0.18d	67.51±0.12b	378.72±1.28a
Pr2	7.63±0.57f	14.01±1.06f	6.28±0.22a	1.80±0.18b	3.42±0.20b	66.86±0.16b	380.00±1.26a
Pr3	7.30±0.59f	14.80±1.09f	6.43±0.26b	1.92±0.36b	3.49± 1.22b	66.06±0.18c	381.31±1.24a
Cn1	8.79±1.01f	10.12±1.43	4.10±0.68b	2.32±0.01a	5.30±1.33b	69.37±1.45d	354.86±1.13c
Cn2	7.84±1.03d	10.22±1.47c	4.13±0.80b	2.36±0.03a	5.39±1.39b	70.06±1.47d	358.29±1.16b
Cn3	6.39±1.05d	10.27±1.49c	4.18±0.84b	2.38±0.04c	5.42±1.40b	70.82±1.50d	361.98±1.18b
Ps1	11.01±1.85a	17.02±0.21a	2.02±0.63c	0.66±0.01f	3.48±0.10c	65.81±0.81d	349.50±0.94f
Ps2	11.03±1.83b	17.05±0.23a	2.05±0.65c	1.05±0.08d	3.87±0.12c	64.95±0.82d	346.45±0.97f
Ps3	11.06±1.81b	17.08±0.24a	2.10±0.68c	1.11±0.10d	3.98±0.13c	64.67±0.84d	345.90±1.00f
Cb1	10.32±1.27c	16.46±1.62b	3.91±0.67b	0.95±0.03f	7.33±1.52a	61.03±0.81f	345.15±1.06d
Cb2	10.67±1.26c	16.52±1.65b	3.95±0.69b	0.98±0.06f	7.36±1.53a	60.52±0.82f	343.71±1.08d
Cb3	10.98±1.24c	16.78±1.68b	3.98±0.72b	1.03±0.07d	7.39±1.54a	59.84±0.83f	342.30±1.12d

Means a, b, c, d within a column with different superscript are significantly different.

C: Control crackers Pr1: Prickly pear peel crackers (3%) Pr2: Prickly pear peel crackers (5%) Pr3: Prickly pear peel crackers (7%) Cn1: Cantaloupe peel crackers (3%) Cn2: Cantaloupe peel crackers (5%) Cn3: Cantaloupe peel crackers (7%) Ps1: Peas peel crackers (3%) Ps2: Peas peel crackers (5%) Ps3: Peas peel crackers (7%) Cb1: Cabbage stalks and outer leaves crackers (3%) Cb2: Cabbage stalks and outer leaves crackers (5%) Cb3: Cabbage stalks and outer leaves crackers (7%).

Also, Song and Thornalley (2007) who found that cabbage outer leaves had a high carbohydrate content comparing to the inside whiter leaves, it had 33.68% carbohydrate in outer leaves against 26.84% in interior leaves. PP crackers were a higher source of protein and moisture comparing to the other supplemented crackers. Protein content was the highest in Cs3 (17.08%), it decreased to be finally the lowest value in C (10.27%). The highest ash content was in CP crackers, that agree with Al-Sayed and Abd El-Rahman findings (2013), and it was so near to the ash content in the C, as shown in Table 3. The lowest ash per cent was (0.95%) found in Cb1. There were no significant correlations between ash in C or the other cracker treatments.

The highest source of fibers appeared in CLS crackers; (7.33, 7.36 and 7.39% for Cb1, Cb2 and Cb3, respectively) followed by CP crackers (5.30, 5.39 and 5.42% for Cn1, Cn2 and Cn3, respectively), the lowest value was found in C (3.36%).

Such results gives a great consideration for these blended crackers to be important nutrition's, economical and dietetic products which gives great choices for the consumers in the local markets. As showed; increases protein content along with reducing carbohydrates.

Colour Measurements of Crackers Supplemented with Waste Powders

Colour analysis of food is an important field, always related strongly to market and consumers acceptability as it controls the first impression of any food product (Abdel- Samie and Abdulla, 2014).

Table 4 shows a clear idea about supplemented cracker's colour after measuring it by Hunter Lab. The highest L* value was 65.12 for Cn3. Values for PP crackers (Ps1, Ps2 and Ps3) were decreased by increasing supplementation, decreasing L* values means less lightness tending to the darkness side that is like CLS crackers (Cb1, Cb2 and Cb3). L* value for C was 64.68. CP crackers (Cn1, Cn2 and Cn3) and PPP crackers (Pr1, Pr2 and Pr3) showed bright colours due to the increase in L* values.

Increasing a* values for crackers (from Ps1 to Cb3); moved them from red colour area and put them into the green colour area, as Table 4 declared. Also, b* values; which indicates yellow-blue colours, increased by increasing percentage adding of these powders. It was 20.89 in Ps1 increased to 21.42 in Ps2 and 23.7 for Ps3. The same aspect applied to CLS crackers (Cb1, Cb2 and Cb3). Higher b* values comparatively indicate that samples exhibited more yellowish colour. L* values for CP crackers (Cn1, Cn2 and Cn3) indicated to brighter crackers given that desirable golden blush colour, with increasing of its values by more percentage adding. That gave a higher significant correlation than C. An increase of both a* and b* values was accrued, which means that these crackers; by more CP percentages; were less green tending to the red colour area and more yellowish colour. These results are similar to Al-Sayed and Abd El-Rahman (2013).

The same results applied to PPP crackers as shown in Table 4, L* a* and b* values had the same trend as described in CP crackers.

A significance relation between C* (Chroma values) for supplemented crackers and control crackers, they increased with more substation, so as ΔE values which increased significantly along with more powders added.

Sensory Evaluation of Crackers Supplemented with Waste Powders

Crispness is a salient textural attribute of toasted foods strongly related to their preference crispness is affected by water content, mechanical properties and morphology of the food. Sound emission and force characteristics during food crushing play a key role in crispness. Crackers had many significant differences in sensory attributes, with all attributes except for salty taste and astringency differing amongst the products (Primo-Martin *et al*., 2008).

Results in Table 5 clear that, with more waste powders supplementations to the crackers, the less crispness value was gained. Ps3 gave the lowest sensory evaluation value for crackers crispness (12.5%). Cn1 had a similar value as C (15.5%) and these were the highest scores. Crispness in all supplemented crackers decreased with more supplementation.

Table 4. Colour values of crackers supplemented with waste powders

Cracker	L*	a*	b*	C*	ΔE
C	64.68±1.02[a]	1.82±0.21[c]	20.48±0.98[c]	11.15±0.74[d]	0.00±0.00[d]
Pr1	58.35±0.68[b]	3.83±0.50[b]	21.43±1.50[b]	25.26±1.26[b]	94.4±1.63[b]
Pr2	61.03±0.70[b]	3.35±0.42[b]	21.33±1.51[b]	24.68±1.22[c]	94.56±1.67[b]
Pr3	61.19±0.73[b]	3.0±0.40[b]	21.32±1.54[b]	24.32±1.18[c]	98.11±1.98[a]
Cn1	54.15±0.55[c]	4.46±0.61[a]	22.97±1.23[a]	27.43±1.43[a]	51.8±0.68[d]
Cn2	54.67±0.58[c]	4.07±0.57[a]	22.14±1.09[a]	26.21±1.36[a]	66.03±1.32[d]
Cn3	55.07±0.61[c]	4.01±0.53[a]	21.51±1.07[b]	25.52±1.25[b]	91.4±1.56[c]
Ps1	65.12±0.66[a]	-0.64±0.15[d]	20.89±1.08[d]	21.15±0.76[d]	51.4±0.67[d]
Ps2	64.05±0.68[a]	-0.41±0.00[d]	21.42±1.06[b]	21.42±0.78[d]	56.4±0.68[d]
Ps3	62.66±0.65[b]	-0.26±0.10[d]	23.7±1.03[a]	23.06±0.95[c]	59.6±0.72[d]
Cb1	50.64±0.53[d]	-1.89±0.74[d]	20.0±0.62[c]	21.89±0.79[d]	56.2±0.66[d]
Cb2	48.85±0.51[d]	-1.17±0.53[d]	18.85±0.65	20.02±0.97[d]	88.9±1.02[c]
Cb3	47.36±0.49[d]	-1.14±0.69[d]	18.81±0.67[d]	19.95±0.62[d]	99.5±1.43[a]

Means [a], [b], [c], [d] within a column with different superscript are significantly different. C: Control crackers Pr1: Prickly pear peel crackers (3%) Pr2: Prickly pear peel crackers (5%) Pr3: Prickly pear peel crackers (7%) Cn1: Cantaloupe peel crackers (3%) Cn2: Cantaloupe peel crackers (5%) Cn3: Cantaloupe peel crackers (7%) Ps1: Peas peel crackers (3%) Ps2: Peas peel crackers (5%) Ps3: Peas peel crackers (7%) Cb1: Cabbage stalks and outer leaves crackers (3%) Cb2: Cabbage stalks and outer leaves crackers (5%) Cb3: Cabbage stalks and outer leaves crackers (7%).

Table 5. Sensory evaluation of crackers supplemented with waste powders

Cracker	Crispness (20)	Odour (20)	Appearance (20)	Overall Acceptability (20)	Colour (20)	Taste (20)
C	15.50±2.11[a]	15.66±2.95[a]	17.12±1.85[a]	16.41±2.01[b]	17.08±1.92[a]	15.49±3.06[a]
Pr1	14.53±2.01[b]	15.05±2.71[b]	17.13±1.78[b]	16.52±1.65[b]	17.13±1.79[b]	14.30±2.06[a]
Pr2	14.49±2.13[b]	15.64±2.75[b]	17.17±1.79[b]	16.56±1.01[b]	17.17±1.88[b]	14.31±2.10[a]
Pr3	13.90±2.00[c]	15.96±2.90[c]	18.10±1.88[a]	16.58±1.23[b]	18.10±1.88[a]	14.35±2.60[a]
Cn1	15.50±2.11[a]	16.13±1.59[a]	18.14±1.88[a]	17.02±1.56[a]	18.14±1.90[a]	15.39±2.60[b]
Cn2	15.21±1.99[a]	16.62±1.75[a]	18.22±1.89[a]	17.44±1.22[a]	18.22±1.87[a]	15.40±2.61[b]
Cn3	14.52±1.97[b]	16.66±1.82[a]	19.00±0.89[a]	17.99±1.64[a]	19.00±1.89[a]	15.71±2.63[a]
Ps1	13.72±1.99[c]	14.96±1.99[a]	16.44±1.91[c]	15.75±1.78[c]	11.44±1.95[c]	14.19±3.00[b]
Ps2	13.53±2.21[c]	14.86 ±2.00[a]	16.39±1.95[c]	15.42±1.45[c]	11.39±1.98[c]	13.59±3.06[d]
Ps3	12.50±0.78[d]	14.78±2.11[b]	15.48±1.98[d]	15.31±1.25[c]	10.48±1.99[d]	13.43±3.02[d]
Cb1	14.59±2.33[b]	6.62±0.95[d]	10.29±2.26[d]	14.40±1.44[d]	9.29±2.26[d]	10.01±0.09[d]
Cb2	14.50±2.41[b]	6.15±0.91[d]	10.15±2.31[d]	14.03±2.46[d]	8.92±2.46[d]	9.41±00.08[d]
Cb3	13.71±2.18[c]	5.06±0.99[d]	9.92±2.46[d]	13.81±2.02[d]	8.15±2.31[d]	9.02±00.06[d]

Means [a], [b], [c], [d] within a column with different superscript are significantly different. C: Control crackers Pr1: Prickly pear peel crackers (3%) Pr2: Prickly pear peel crackers (5%) Pr3: Prickly pear peel crackers (7%) Cn1: Cantaloupe peel crackers (3%) Cn2: Cantaloupe peel crackers (5%) Cn3: Cantaloupe peel crackers (7%) Ps1: Peas peel crackers (3%) Ps2: Peas peel crackers (5%) Ps3: Peas peel crackers (7%) Cb1: Cabbage stalks and outer leaves crackers (3%) Cb2: Cabbage stalks and outer leaves crackers (5%) Cb3: Cabbage stalks and outer leaves crackers (7%).

The most unlikable cracker's odour occurred in CLS crackers; they gained the lowest scores in odour evaluation, the more supplementation of this waste powder the less evaluation score it claim (6.62, 6.15 and 5.05% for Cb1, Cb2 and Cb3, respectively). The best odour evaluation was found in 7% cantaloupe peel crackers Cn3 (16.66%).

The sensory panelist registered that supplemented crackers with CP powder gained the highest scores in colour test by more supplementation, it was significantly higher than C; it was (19.0, 18.22 and 18.14%) for Cn3, Cn2 and Cn1, respectively. Prickly pear peel crackers had the second order in appearance evaluation and valued 18.1, 17.17 then 17.13% for Pr3, Pr2 and Pr1, respectively. The opposite had been occurred with PP crackers (Ps1, Ps2 and Ps3) and CLS crackers (Cb1, Cb2 and Cb3). The lowest taste score were for Cb3 (9.92%), and the highest was (15.71%) for Cn3.

Overall acceptability had the highest score in Cn3 (17.99%). While the score decreased with gradually added percentages of PP followed by CLS to the supplemented crackers. That means less overall acceptability with more supplementation from the waste sources. The same results applied to colour and taste evaluations. Results in Table 5 showed significantly correlations between C and all waste powder crackers under the study.

The sensory evaluation gave a conclusive conclusion that CP crackers gained the highest scores for sensory evaluation than the C and other supplemented crackers which make it a great choice as a DF source. The panelists did not give high scores to CLS crackers as a good source in all the panelist items, especially with more supplementation of it. These results agree with those of Al-Sayed and Abd El-Rahman (2013).

Chemical Compositions of Yoghurt Fortified with Waste Powders

Results in Table 6 present chemical compositions of fortified yoghurt; it show that control yoghurt (Y) had the highest moisture content (87.12%) comparing to yoghurt with 2.5% prickly pear peel (Yp2) which had the lowest value (78.84%).

The highest protein and fat contents by more fortification of powder were found in prickly pear fortified yoghurt (Yp1 and Yp2), it might be due to that prickly pear peel had higher protein and fat content comparing to CP powder. Y had the lowest protein value (3.6%), the highest protein content was (5.57) for Yp2. Control yoghurt (Y) had traces of ash content with no crude fibers; that is why there contents of every kind of fortified yoghurt was the same amount of peel powder added into it.

Fat content has a significant different between prickly pear peel (Yp1, Yp2) and cantaloupe peel yoghurts (Yc1 and Yc2), but it was noticed that fat content reduces by more fortification of peel powder. It was 4.02% in Yp1 decreased to 4.0% in Yp2 that is like cantaloupe peel yoghurt (Yc1 and Yc2); which its fat content was 3.94% reduced to 3.91% by more substitution. These results agree with those of Thu *et al.* (2011) when they structured yoghurt by DF particles. The current results shows that by more percentage added of waste powders, the more nutritional, mineral values and less carbohydrate content were found, also syneresis happened causing decreases in fat values in the fortified yoghurt.

Carbohydrates were the highest in Yc1 then Yc2 followed by Yp2, Yp1 and the least content was in Y (7.29, 7.24, 6.59, 6.48 and 6.18%), respectively. There were no significations between fortified kinds of yoghurts.

Colour Analysis of Yoghurt Fortified with Waste Powders

Table 7 presents colour measurements. Y had the maximal lightness value (78), a gradual decrease of lightness with the proportional increase of each peel powder (it gets darker).

Control yoghurt had (3.97) in a* value which put it in the red zone. A decrease occurred in the fortified yoghurts as seen in Table 7. The b* value present blue to yellow colour, with the increase of this value it gives an indicator of yellow colour. Data showed that along with the increase of powder concentration there were also an increase of b* values for fortified yoghurt comparing to the Y, the highest value was registered in Yc2 (17.61), and the lowest value was 11.24 in Y. This showed that cantaloupe peel yoghurt was generally more yellowness than prickly pear peel yoghurt, and by more peel adding percentage; the more b* score to attend into yellow area colour. Chroma values (C*) were increased gradually from Y to Yc2.

Table 6. Chemical composition of yoghurt fortified with waste powders

Yoghurts / Components (%)	Y	Yp1	Yp2	Yc1	Yc2
Moisture	87.12±3.01[a]	81.16±3.40[b]	78.84±3.7[b]	81.67±3.48[c]	79.58±3.51[a]
Protein	3.60±0.95[c]	5.34±1.13[a]	5.57±1.18[a]	4.15±0.84[c]	4.22±0.87[b]
Fat	3.10±0.68[c]	4.02±0.81[a]	4.00±0.76[a]	3.94±0.69[b]	3.91±0.65[b]
Ash	0.80±0.00[d]	1.50±0.68[b]	2.50±0.68[a]	1.51±0.68[b]	2.51±0.68[a]
Fiber	0.00±0.00[d]	1.50±0.68[b]	2.50±0.68[a]	1.51±0.68[b]	2.51±0.68[a]
Carbohydrate	6.18±1.54[c]	6.48±1.61[b]	6.59±1.62[b]	7.24±1.73[a]	7.29±1.74[a]
Total Energy (kcal/100g)	67.02±2.03[a]	87.46±2.53[b]	88.64±2.57[a]	81.02±2.49[c]	81.23±2.41[c]

Means [a], [b], [c], [d] within a column with different superscript are significantly different. Y: Control yoghurt Yp1: Prickly pear peel yoghurt (1.5%) Yp2: Prickly pear peel yoghurt (2.5%) Yc1: Cantaloupe peel yoghurt (1.5%) Yc2: Cantaloupe peel yoghurt (2.5%).

Table 7. Colour values of yoghurt fortified with waste powders

Yoghurt	L*	a*	b*	C*	ΔE
Y	78±0[a]	3.97±0[a]	11.24±0[a]	7.99±0[a]	0.00±0.00[d]
Yp1	69.22±0[d]	-1.02±0[c]	11.96±0[a]	10.41±0[b]	57.05±0[c]
Yp2	56.13±0[c]	-0.83±0[d]	14.33±0[b]	13.31±0[d]	74.01±0[b]
Yc1	70.14±0[d]	1.11±0[d]	14.7±0[b]	15.81±0[d]	74.37±0[b]
Yc2	69.71±0[b]	1.4±0[d]	17.61±0[d]	19.01±0[c]	86.5±0[a]

Means [a], [b], [c], [d] within a column with different superscript are significantly different. L*: Lightness, a*: red - green, b*: yellow-blue, C*: Chroma; ΔE: total color difference between control and treatment. Y: Control yoghurt Yp1: Prickly pear peel yoghurt (1.5%) Yp2: Prickly pear peel yoghurt (2.5%) Yc1: Cantaloupe peel yoghurt (1.5%) Yc2: Cantaloupe peel yoghurt (2.5%)

It can be concluded that colour of fortified yoghurt became less red, more yellow and brighter with the addition of cantaloupe peel (Yc1 and Yc2) followed by (Yp1 and Yp2) comparing with Y, which means that with the addition of peel powder to the yoghurt gave brighter, more yellow colour. That could be less acceptable to panelists, and also might be a change of the routing of control yoghurt colour which gave these new kinds of yoghurt a good market value. Sangita *et al.* (2016) referred that in probiotic peanut yoghurt colours value tended to be redder and less bright.

Sensory Evaluation of Yoghurt Fortified with Waste Powders

Triangle test was performed to examine the acceptance of the fortified yoghurt. As shown in Table 8, the samples revealed that Y had the highest preferred scores all sensory evaluation panelists. Increasing powder supplementation in fortified yoghurt caused decreases in panelist scores, except acidity; which had a slight increase in panelist refers. Panelists gave high scores in acidity for Yp2 (8.41%) followed by Yp1 (8.35%). Table 8 presents that the higher score in taste test was for the Y (44.48%). After that a gradual decrease were found in fortified yoghurt. It was also found that control yoghurt's

Table 8. Sensory evaluation of yoghurt fortified with waste powders

Yoghurt	Taste (45)	Texture (35)	Appearance (10)	Acidity (10)	Total score (100)
Y	44.48±2.97[a]	32.12±1.39[a]	7.48±1.29[a]	8.24±0.59[a]	92.32±19.02[a]
Yp1	38.26±2.86[b]	31.12±1.45[a]	5.06±1.01[d]	8.35±0.52[a]	82.79±18.04[b]
Yp2	38.18±2.77[b]	29.12±1.39[b]	5.17±1.21[d]	8.41±0.48[a]	80.88±17.02[c]
Yc1	38.48±2.90[b]	31.12±1.39[a]	6.53±1.34[c]	8.31±0.55[a]	84.44±18.24[a]
Yc2	37.48±2.75[c]	30.12±1.39[a]	6.87±1.20[c]	8.30±0.53[a]	82.77±18.16[b]

[a], [b], [c], [d]: Means within a column with different superscript are significantly different.

Y: Control yoghurt Yp1: Prickly pear peel yoghurt (1.5%) Yp2: Prickly pear peel yoghurt (2.5%) Yc1: Cantaloupe peel yoghurt (1.5%) Yc2: Cantaloupe peel yoghurt (2.5%)

texture was the most likable in the sensory panelist. Then it was equal preferences to both Yp1 and Yp2 (31.12%). Fortified yoghurt's appearance was the highest in Y and the lowest score was in Yp1. No significant relations were found according texture, appearance, acidity and total score according to the panelist's opinions. Significant relations were found between Y and taste, there were granule tastes. However, from the technological point of view the addition of fruit fiber into a food product with a smooth texture such as yoghurt is a challenge, because of its granule taste, which resulted to have a low sensory evaluation scores (Ibrahim *et al*., 2016).

Conclusion

It could be concluded that cantaloupe peel powder could be used as a suitable peel powder source comparing to prickly pear's peel, peas peel and cabbage stalks and outer leaves. Using waste powders is a global trend to nutritional, variety and economical products in local markets. Substituting or fortifying waste powder in both crackers and yoghurt showed an increase in protein content along with reducing carbohydrates by more substitution, which make a change of the routing of ordinal crackers and yoghurt's colour which gave these new kinds a good market value. It is recommended using cantaloupe peel powder to both products; by adding 7% of CP powder to supplement crackers and 1.5% of CP powder to fortified yoghurt.

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الاســـتفادة من مســحوق مخلفـــات الفـــواكـــه والخضروات فى تدعيم بعض المنتجات الغذائية

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أجريت هذه الدراسة لتقدير التركيب الكيميائي، الخواص الفيزيائية والحسية لكلا من المقرمشات والزبادي المدعمة بمسحوق مخلفات الفواكه والخضروات، تم استخدام مساحيق قشور التين الشوكى، الكانتلوب، البسلة ومخلفات رؤوس الكرنب وأوراقه الخارجية، تم استبدال ٣%، ٥% و٧% من دقيق القمح للمقرمشات بجميع أنواع مساحيق المخلفات.تم استخدام مسحوق قشور كلا من الكانتلوب والتين الشوكى بنسب ١.٥% و ٢.٥% إلى اليوجورت، أفادت النتائج أن مسحوق قشور التين الشوكى كانت أعلى نسبة فى المحتوى من الدهون (١٨.٦٦%)، نسبة البروتين والكربوهيدرات فى مسحوق قشور البسلة أعلى من باقى أنواع المساحيق الغذائية المستخدمة فى هذه الدراسة (١٩.٢٥و ٥٠.٢٩%) على التوالى، وجد أيضا أن رؤوس الكرنب والأوراق الخارجية كان بها اعلى محتوى من الألياف الخام (٣٩.٤٦%)، قدرة الاحتفاظ بالماء كانت الأعلى في مسحوق قشور الكانتلوب ولكن مسحوق رؤوس الكرنب واوراقه الخارجية كان الأعلى فى معظم الخواص الفيزيائية تقريباً، لوحظ أنه بزيادة النسب المضافة من مساحيق المخلفات للمقرمشات والزبادى حدث تحسن ملموس فى التركيب الكيميائى لكلا المنتجين الغذائيين، كان لإضافة مساحيق المخلفات تأثير ملموس على الخواص اللونية لهذه المنتجات، حيث لوحظ أن اليوجورت المضاف إليه مسحوق قشور الفاكهة كان لونه مائل للأصفر الباهت وأكثر سطوعا مقارنة بعينة الكنترول، المقرمشات التى تم استبدال جزء من الدقيق بها بمسحوق قشور البسلة ومسحوق مخلفات رؤوس الكرنب والأوراق الخارجية كانت مائلة أكثر للون الأخضر، أظهر التحكيم الحسى للمقرمشات التى بها نسبة ٧% من قشور الكنتالوب أنها حصدت أعلى نتائج التحكيم الحسى، أكثرحتى من المقرمشات الكنترول، بناء على هذه الدراسة يوصى بإضافة نسبة ٧% من مسحوق قشور الكانتلوب إلى المقرمشات و١.٥% من مسحوق قشور الكانتلوب لليوجورت لتعطى أفضل النتائج.

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