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Physicochemical, Microbiological and Sensory Properties of Low Fat Probiotic Yoghurt Fortified with Mango Pulp Fiber Waste as Source of Dietary Fiber

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ABSTRACT

Physicochemical, microbiological and sensory properties of low fat probiotic yoghurt fortified with mango pulp powder were investigated. Mango pulp powder was added at ratios of 1, 2 and 3 %. Yoghurt treatments were analyzed when fresh and after 5, 10 and 15 days of storage at 5 ± 1˚C. Fortification of low fat yoghurt with mango pulp powder increased the total solids, protein, ash, pH, dietary fiber, viscosity, phenolic contents and antioxidant activity. Increments were proportional to the mango pulp powder fortification concentration. On the other hand, the acidity and synersis decreased with the increase of the added mango pulp fiber. Fortification of low fat yoghurt with mango pulp powder improved the viability of *Streptococcus thermophiles*, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* and this improvement was proportional to the concentration of mango pulp powder. Low fat yoghurt made with added of 3% of mango pulp powder achieved the highest scores for sensory properties, compared to other treatments. It could be concluded that mango pulp powder can be used at a rate of 3% as a source of bioactive components and dietary fiber in making of low fat yoghurt, which enhanced its physicochemical, microbiological, antioxidant and sensory properties.

Keywords: probiotic yoghurt, mango pulp fiber waste, physicochemical, microbiological, sensory properties.

INTRODUCTION

Yoghurt is produced from fermentation of milk using lactic acid bacteria (*Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *Bulgaricus*). The quality of yoghurt is influenced with some factors such as milk base, starter culture and manufacturing conditions (Pakseresht *et al*, 2019). Yogurt has a better digestibility of proteins than milk and many latent positive effects on health by providing the human body prebiotic and probiotic bacteria. (Dabija *et al*., 2018). Most probiotic foods at the markets worldwide are milk based and few attempts are made for development of probiotic foods using other fermentation substrates such as cereals (Baú *et al*, 2014: Atwaa *et al*, 2019).

During the past two decades, consumers have tended to use low-fat dairy products, but lowering the fat content in dairy products, especially yogurt, reduces the rheological and organoleptic properties of the product (Ozer *et al*. 2007). The fat content of yoghurt improved the physical characteristics such syneresis and viscosity, fat also improves the sensory properties in yoghurt. (Ramchandran and Shah 2008: Pakseresht *et al*, 2019). However, since the use of synthetic stabilizers in dairy products is not allowed in many countries, various methods must be used in order to achieve favorable consistency in skimmed or low-fat dairy products. (Ozer*et al*. 2007).

Large quantities from mango are processed into various other forms, such as puree, juices, concentrates, nectars, and dried fruit products which have worldwide popularity. Mango fruit consists of approximately 35 % edible pulp, 9-40 % inedible kernel and 7-40 % inedible peel, depending on the variety *(*Berardini *et al*, 2020*)*. Huge amount of waste is generated during industrial processing. Such by products are of a serious disposal problem. Byproducts from mango have been recently reported as a dietary fiber and natural antioxidant source (Sudha *et al*, 2015).

Dietary fiber (DF) is indigestible plant matter comprising of cellulose, hemicellulose, lignin, pectin, β-glucans and gums (Figuerola *et al*, 2005).

The fortification of milk and milk products with dietary fiber has resulted from discussed reasons, probiotic or synbiotic effect, enhancement of fiber content of the product, replacement of fat or for some technological benefits, bulking agent along with artificial sweeteners or micronutrient premixes (Arora *et al*, 2015)

The aim of this study to the effect of fortification of low fat probiotic yoghurt with mango pulp powder on physicochemical, microbiological, antioxidant, and sensory properties of low fat yoghurt.

MATERIALS AND METHODS

Materials

Fresh buffalo's milk standardized to 3% fat was obtained from Dairy Technology Unit, Food Science Department, Faculty of Agriculture, Zigzag University, Egypt. Mango pulp fiber waste were obtained from Juhayna Company 6th October City, Egypt, The mango pulp fiber waste (MPFW) was immediately collected after the filtration of mango pulp and transported under cool conditions and kept in Deep freezer (-20 ˚C) till use, then washed with distilled water and dried in an oven at 50˚C, before grinding to a powder and finally kept at 4˚C until use.

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Starter culture containing *Streptococcus thermophilus, Lactobacillus acidophilus* and *Bifidobacterium bifidum* (ABT-5) were obtained from the Microbiological Resources Center (MIRCEN), Faculty of Agric. Aim Shams Univ., Egypt. 1, 1-diphenyl-2-picrylhydrazyl (DPPH), Gallic acid and other chemicals and reagents were purchased form Sigma-Aldrich (MO,IL USA).

Methods

Determination of total phenolic content:

The total phenolic content (TPC) was determined according to Kaur and Kapoor (2002) .The total phenolic content was expressed as gallic acid equivalents (mg GAE/100g dry weight basis) through the calibration curve of Gallic acid.

Determination of total flavonoid content

The total flavonoid content (TFC) of the extract was determined by the aluminum chloride colorimetric method according to Chang *et al*, (2002). The total flavonoid content was calculated and expressed as mg of quercetin equivalent (mg QE/100g dry weight basis) using the calibration curve. Quercetin linearity range of the calibration curve was 10- 1000 mg/ml.

Determination of radical scavenging activity (Scavenging DPPH):

The radical scavenging activity was evaluated by the DPPH assay according to Brand Williams *et al*, (1995). The antioxidant activity percentage (AOA %) was determined according to Mensor *et al*, (2001) as follows:

$$\textbf{AOA(\%)} = 1 - Abs_{sample} \_ Abs_{blank} / Abs_{control \times 100} \quad (1)$$

Yoghurt manufacture:

Yoghurt treatments were prepared from 5 treatments as follows:

Milk containing 3% fat as a control (C)

Low fat buffalo's milk (1% fat) (C1)

Low fat yoghurt supplemented with 1% mango pulp fiber waste powder (T1)

Low fat yoghurt supplemented with 2% mango pulp fiber waste powder (T2)

Low fat yoghurt supplemented with 3% mango pulp fiber waste powder (T_3)

The supplemented milk bases were homogenized and heated to 90 ˚C for 15 min., cooled to 42 ± 1 ˚C, inoculated with 2% of ABT5 starter cultures, filled in plastic cups and incubated at 42 ˚C until a uniform coagulation was obtained. The yoghurt samples were kept at 5 ± 1˚C, and analyzed after fresh, 5, 10 and 15 day of manufacturing. This experiment was triplicated.

Methods of Analysis:

Determination of chemical analysis

Total solids, fat, total protein (TN) contents, titratable acidity and soluble dietary fiber (SDF), and Insoluble dietary fiber (IDF) of MPFW and yoghurt samples were determined according to AOAC (2007). The changes in pH in the yoghurt samples were measured using a laboratory pH meter with glass electrode (HANNA, Instrument, Portugal).

Rheological measurements:

The syneresis and viscosity of yoghurt samples was measured according to Aryana (2003).The quantity of whey collected from every sample in graduated cylinder after 2 h of drainage at 20 ˚C was used as index of syneresis. Viscosity of yoghurt samples was determined using Rotational Viscometer Type Lab. Line Model 5437. Results expressed as CPS.

Microbiological analysis:

Differential media used for enumeration of *S. thermophilus*, *L. acidophilus* and *Bifidobacterium BB*-12 where those previously described by Martin-Diana *et al*. (2003).Total bacterial count was determined according to Houghtby *et al*., (1992).,coliform bacteria and yeast and mould counts were determined according to Marshall (1992).

Sensory evaluation:

The sensory properties of yoghurt samples were assessed according to Nelson and Trout (1981), by 10 panel members of the Dairy Sci., Dep., Fac. Agric., Zagazig, Univ. for flavour (60) body and texture (30) and appearance (10) .

Statistical analysis:

The obtained results were evaluated statistically using analysis of variance as reported by McClave & Benson (1991). In addition the other reported values were expressed as mean ±SD and ±SE, two – tailed Student's t test was used to compare between different groups.

RESULTS AND DISCUSSION

Chemical composition and antioxidant properties of pulp fiber waste powder (MPP).

The chemical composition and antioxidant properties of mango pulp fiber waste powder (MPP) were illustrated in Table (1). Moisture, protein, fat, ash, total dietary fiber, insoluble dietary fiber and soluble dietary fiber contents of MPP were (8.49, 7.25, 1.48, 2.52, 55,4, 36.6 and 18.8 g/100g, respectively. These results are in agreement with the data obtained by Nely *et al*., 2007, and Sudha *et al*., (2015).

Total phenolic content TPC of MPP was 128.0mg/100g, total flavonoids content TFC was 43.8 mg/100g, while the radical scavenging activity RSA (%) was 86.20%. These results agree with those previously reported by Sudha *et al*., (2015), who found that TPC of mango pulp fiber waste was 105 (mg /100g), while TFC was 41.74 (m/100g).

Table 1. Chemical composition and antioxidant properties of mango pulp fiber waste powder.

Components	Concentration
Chemical composition (g/100g)	
Moisture	8.49±0.09
protein	7.25±0.4
Fat	1.48±0.07
Ash	2.52±0.01
Total dietary fiber	55.4±2.04
Insoluble dietary fiber (%)	36.6±1.8
Soluble dietary fiber (%)	18.8±0.64
Antioxidant properties	
Total phenolic (mg/100g)	128.0±5.8
Total flavonoids (mg/100g)	43.8±1.6
Radical scavenging activity (RSA) %	86.20±2.0

Chemical composition of low fat probiotic yoghurt fortified with mango pulp fiber waste powder:

Data indicated in Table (2) show that full fat yoghurt (3% fat) was of the highest total solids (TS) and it was significantly ($P \leq 0.05$), compared with low fat yoghurt treatments, while the control low fat yoghurt treatment (C1) exhibited the least TS content. This decrease in TS content was due to the reduction of fat from milk yoghurt treatments. The TS content of low fat yoghurt containing MPP increased gradually by increasing the percentage added. The TS content of all yoghurt treatments slightly increased as storage period progressed.

Control full fat yoghurt (C) contained the lowest protein content, reduced the fat from low fat milk yoghurt increased the protein content, compared with control full fat yoghurt. The total protein of low fat yoghurt containing MPP slightly increased by increasing the percentage of addition, compared to control low fat yoghurt (C1). The total protein of all yoghurt treatments slightly increased as storage period progressed. Control full fat yoghurt (C) contained the highest fat content and it was significantly ($P \leq 0.05$), compared with low fat yoghurt treatments. On the other hand, supplementation of low fat milk with MPP did not affect the fat content of the resultant low fat yoghurt this may be due to a low fat content of MPP (Sudha *et al*., 2015).

Total dietary fiber content of low fat yoghurt treatments increased by adding of MPP in the yogurt samples, and these increments were proportional to the fortification ratio. These results came in agreement with those reported by Hasani *et al*., (2017), and Atwaa and Elmaadawy(2019), who found that low-fat yoghurt supplemented with lupine flour or garden cress seeds powder were the highest positive effect on physicochemical properties.

Table 2. Chemical composition of low fat yoghurt fortified with mango pulp fiber waste powder during storage at refrigerator temperature (5 ± 1˚C) for 15 day

Components (%)	Storage period (Day)	Treatments				
		C	C_1	T_1	T_2	T_3
TS	Fresh	12.22±0.54ᵃ	10.28±0.42ᶜ	11.04±0.50ᵇ	11.90±0.46ᵇ	12.02±0.44ᵃ
	5	12.36±0.50ᵃ	10. ±0.32ᶜ	11.62±0.35ᵇ	12.02±0.40ᵃᵇ	12.24±0.38ᵃ
	10	12.98±0.48ᵃ	11.12±0.44ᶜ	11.96±0.50ᵇ	12.44±0.36ᵃᵇ	12.78±0.52ᵃ
	15	13.42±0.42ᵃ	11.76±0.34ᶜ	12.38±0.40b	12.98±0.52ᵃᵇ	13.26±0.42ᵃ
Fat	Fresh	3.04±0.12ᵃ	1.14±0.09ᵇ	1.18±0.07ᵇ	1.24±0.09ᵇ	1.28±0.10ᵇ
	5	3.16±0.10ᵃ	1.25±0.12ᵇ	1.28±0.12ᵇ	1.30±0.08b	1.36±0.11ᵇ
	10	3.34±0.14ᵃ	1.52±0.10ᵇ	1.55±0.10ᵇ	1.34±0.11b	1.40±0.09ᵇ
	15	3.62±0.16ᵃ	1.84±0.11ᵇ	1.88±0.09ᵇ	1.40±0.07ᵇ	1.46±0.12ᵇ
Protein	Fresh	3.46±0.14ᶜ	3.72±0.12ᵇ	3.79±0.15ᵇ	3.86±0.16ᵃᵇ	3.94±0.11ᵃ
	5	3.60±0.12ᶜ	3.90±0.14ᵇ	3.96±0.17ᵇ	4.04±0.14ᵃᵇ	4. 12±0.13ᵃ
	10	3.78±0.15ᶜ	4. 04±0.18ᵇ	4.12±0.13ᵇ	4.20±0.12ᵃᵇ	4.26±0.15ᵃ
	15	4.00±0.13ᶜ	4.30±0.15ᵇ	4.38±0.12ᵇ	4. 46±0.16ᵃᵇ	4.54±0.12ᵃ
Fiber	Fresh	0.00±0.001ᵈ	0.00±0.002ᵈ	0.50±0.01ᶜ	1.02±0.05ᵇ	1.58±0.08ᵃ
	5	0.00±0.002ᵈ	0.00±0.002ᵈ	0.84±0.03ᶜ	1.36±0.04ᵇ	1.92±0.06ᵃ
	10	0.00±0.002ᵈ	0.00±0.001ᵈ	1.02±0.04ᶜ	1 .50±0.02ᵇ	2.22±0.03ᵃ
	15	0.00±0.001ᵈ	0.00±0.001ᵈ	1.38±0.07ᶜ	1.84±0.05ᵇ	2.64±0.09ᵃ

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**
C: control yoghurt **C_1: Low fat yoghurt (1% fat).** **T_1: Low fat yoghurt treated with 1% mango pulp fiber waste powder**
T_2: Low fat yoghurt treated with 2% mango pulp fiber waste powder **T_3: Low fat yoghurt treated with 3% mango pulp fiber waste powder**

Acidity, pH, whey syneresis and viscosity of low fat yoghurt fortified with mango pulp fiber waste powder:

Results in Table (3) show that control full fat yoghurt had the lowest acidity, while control low fat yoghurt had the highest acidity , fortification of yoghurt milk with MPP at different concentrations decreased the acidity of low fat yoghurt, compared with control low fat yoghurt and these decreasing was proportional to the MPP fortification ratio . The acidity of all yoghurt treatments slightly increased as storage period progressed.

Table 3. Acidity, pH, whey syneresis and viscosity of low fat yoghurt fortified with mango pulp fiber waste powder during storage at refrigerator temperature (5 ± 1˚C) for 15 day

Parameters	Storage period (Day)	Treatments				
		C	C1	T_1	T_2	T_3
Acidity %	Fresh	0.88±0.02ᵃᵇ	0.90±0.05ᵃ	0.86±0.03ᵇ	0.82±0.02ᶜ	0.80±0.04ᶜᵈ
	5	0.96±0.04ᵃᵇ	0.98±0.03ᵃ	0.92±0.0ᵇ	0.88±0.07ᵇᶜ	0.86±0.06ᵇᶜ
	10	1.14±0.05ᵇ	1.22±0.02ᵃ	1.02±0.04ᶜ	0.94±0.08ᶜᵈ	0.92±0.05ᵈ
	15	1.26±0.03ᵇ	1.34±0.05ᵃ	1.10±0.03ᶜ	1.02±0.04ᵈ	1.00±0.02ᵈᶜ
pH	Fresh	4.60±0. 04ᶜ	4.28±0.06ᵈ	4.60±0.02ᶜ	4.62±0.04ᵇ	4.66±0.05ᵃ
	5	4.52±0.06ᶜ	4.06±0.04ᵈ	4.55±0.05ᶜ	4.70±0.04ᵇ	4.78±0.03ᵃ
	10	4.44±0.03ᶜ	3.92±0.06ᵈ	4. 48±0.04ᶜ	4.55±0.03ᵇ	4.64±0.05ᵃ
	15	4.30±0.04ᶜ	3.68±0.05ᵈ	4.36±0.05ᶜ	4.44±0.06ᵇ	4.50±0.04ᵃ
Whey syneresis (ml/100gm	Fresh	24.00±1.12ᵉ	34.00±1.08ᵃ	32.00±1.14ᵇ	28.00±1.14ᶜ	26.00±1.12d
	5	27.00±1.08ᵉ	38.00±1.12ᵃ	35.00±1.08ᵇ	31.00±1.15ᶜ	30.00±1.08ᵈ
	10	31.00±1.14ᵉ	42.00±1.09ᵃ	39.00±1.16ᵇ	36.00±1.12ᶜ	34.00±1.14ᵈ
	15	33.00±1.09ᵉ	46.00±1.16ᵃ	42.00±1.12ᵇ	39.00±1.09ᶜ	36.00±1.08ᵈ
Viscosity (C. P.S.)	Fresh	5420±106ᵃ	4220±77.0e	4360±85.0ᵈ	4620±95.0ᶜ	5040±102ᵇ
	5	5490±118ᵃ	4280±82.0ᵉ	4410±92.0ᵈ	4670±84.0ᶜ	5120±106ᵇ
	10	5530±124ᵃ	4330±72.0ᵉ	4460±88.0ᵈ	4820±100.0ᶜ	5180±95.0ᵇ
	15	5570±114ᵃ	4390±85.0ᵉ	4520±94.0ᵈ	4890±90.0ᶜ	5240±114ᵇ

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

Changes in pH values of yoghurt treatments as affected by adding of MPP followed almost opposite trend to acidity .These results are in agreement with those reported by Al-hamdani *et al* (2015),Hasani *et al*., (2017) and Atwaa and Elmaadawy (2019) they found that fortification of low fat yoghurt with barley, lupine flour or garden cress seeds powder decreased the acidity of treated low fat yoghurt.

Whey syneresis increased by the reduction of fat from yoghurt milk but fortification of yoghurt with MPP significantly reduced whey syneresis, compared with control low fat yoghurt

(C1) and this reduction was proportional to the MPP fortification ratio Table (5).Control full fat yoghurt had the lowest whey syneresis, while control low fat yoghurt had the highest whey syneresis. The whey syneresis of all yoghurt treatments increased as storage period progressed. These results might be due to increasing the dietary fiber content of MPP (Sudha *et al*., 2015) which increased the water holding capacity of resultant curd. A similar observation was found by Dabija *et al*, (2018) in yoghurt containing inulin, pea, oat and wheat, and Atwaa and Elmaadawy (2019) in low fat yoghurt containing cress seed powder.

Control low fat yoghurt (C1) was significantly less viscous than full fat yoghurt (control) but fortification of yoghurt milk with MPP significantly increased ($P \leq 0.05$), the viscosity of low fat yoghurt. The increase was proportional to the MPP fortification ratio. This increase could be attributed to the water hydration of MPP. The viscosity of all yoghurt treatments increased as storage period progressed. Similar results were observed by Dabija *et al*, (2018), who found that addition of inulin, pea, oat and wheat to yoghurt increased its viscosity and reduced whey syneresis compared to control yoghurt. Also, Atwaa and Elmaadawy (2019) observed that fortification of low fat yoghurt with garden cress seed powder increased its viscosity and reduced whey syneresis compared to control low fat yoghurt.

Total phenolic content and radical scavenging activity of low fat yoghurt fortified with mango pulp fiber waste powder.

Table 4 shows the total phenolic content (TPC) and radical scavenging activity (RSA %) of low fat yoghurt fortified with mango pulp fiber waste powder. It could be seen that, TPC and RSA% of low fat yogurt supplemented with MPP was increased by increasing the supplementation ratio. The TPC and RSA% of all yoghurt treatments decreased as storage period progressed. These results are in agreement with those reported by Jambi (2018) who found that total phenolic content and radical scavenging activity of yogurt fortified with date pits powder were increasing date pits powder ratios increased. Also, Atwaa and Elmaadawy (2019) observed that fortification of low fat yogurt with 3 % garden cress seed powder increased the total phenolic content and radical scavenging activity of low fat yogurt.

Table 4. Total phenolic content and radical scavenging activity of low fat yoghurt fortified with mango pulp fiber waste powder during storage at refrigerator temperature (5 ± 1˚C) for 15 day

Parameters	Storage period (Day)	Treatments				
		C	C_1	T_1	T_2	T_3
Total phenolic content (mg /100 g)	Fresh	70.60±1.2^d	70.40±1.6^d	72.20±1.8^c	74.60±1. 5^b	76.40±1.7^a
	5	66.50±1.6^d	66.20±1.3^d	70.70±1.5^c	72.80±1.2^b	74.20±1.4^a
	10	58.70±1.4^d	58.20±1.5^d	66.30±1.2^c	69.40±1.3^b	71.40±1.2^a
	15	54.60±1.5^d	54.30±1.2^d	58.80±1.4^c	65.30±1.6^b	68.50±1.5^a
Radical scavenging activity RSA %	Fresh	22.60±1.00^d	21.30±1.18^d	30.20±1.28^c	42.30±1.20^b	65.40±1.16^a
	5	20.70±1.12^d	20.10±1.22^d	26.70±1.16^c	38.80±1.12^b	60.70±1.14^a
	10	16.50±1.08^d	15.00±1.16^d	20.80±1.14^c	33.40±1.18^b	54.90±1.12^a
	15	10.80±1.14^d	10.20±1.24^d	15.60±1.18^c	27.80±1.22^b	48.20±1.26^a

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

Microbiological examination of low fat yoghurt fortified with mango pulp fiber waste powder

The differences in total bacterial counts of low fat yoghurt made with MPP at different concentrations are presented in Table (5). The results indicated that total bacterial count decreased gradually as storage period progressed until the end of storage period. Low fat yoghurt treatments fortified with MPP had the highest counts of total bacterial count. Total bacterial count increased with increasing the fortification ratio.

Yeast and mould counts increased in all treatments up to the end of storage period. Low fat yoghurt treatments fortified with MPP had the lowest yeast and moulds counts. Yeast and moulds counts decreased with increasing the fortification ratio.

Coliform bacteria not detected in all treatments up to the end of storage period. The general trend of these results agreed with those reported Elsanhoty *et al*, (2009) and Habib *et al*,(2018).

Streptococcus *thermophiles* and *Lactobacillus acidophilus* counts increased gradually in all treatments up to 10 days form storage and then decreased at the end of storage period. Low fat yoghurt treatments fortified with MPP had the highest *Streptococcus thermophiles* and *Lactobacillus acidophilus* counts. *Streptococcus thermophiles and Lactobacillus acidophilus counts* increased with increasing the fortification ratio

Bifidobacterium. bifidum counts increased gradually in all treatments up to the end of storage period. Low fat yoghurt treatments fortified with MPP had the highest *Bifidobacterium. bifidum* counts. *Bifidobacterium. bifidum counts* increased with increasing the fortification ratio.

Table 5. Microbiological examination of low fat yoghurt fortified with mango pulp fiber waste powder during storage at refrigerator temperature (5 ± 1˚C) for 15 day.

Properties	Treatments	Storage period (days)			
		Fresh	5	10	15
T.B.C cfu/10^7 g	C	46	40	35	32
	C1	55	49	46	43
	T1	58	52	49	47
	T2	60	55	50	49
	T3	63	60	47	45
Coliform cfu/10 g	C	ND	ND	ND	ND
	C1	ND	ND	ND	ND
	T1	ND	ND	ND	ND
	T2	ND	ND	ND	ND
	T3	ND	ND	ND	ND
Yeasts & Moulds cfu/10^2 g	C	ND	7	15	18
	C1	ND	9	12	14
	T1	ND	4	8	12
	T2	3	5	7	10
	T3	3	3	6	8
Streptococcus thermophiles cfu/10^7 g	C	53	66	42	36
	C1	56	72	63	52
	T1	62	78	69	58
	T2	65	83	72	60
	T3	67	85	76	64
Lactobacillus acidophilus cfu/10^7 g	C	42	40	33	30
	C1	50	47	36	32
	T1	62	56	50	45
	T2	70	67	66	60
	T3	82	80	72	64
Bifidobacterium. bifidum cfu/10^7 g	C	40	37	32	30
	C1	42	35	26	23
	T1	50	46	30	27
	T2	58	52	42	36
	T3	64	58	46	40

ND= not detected.

The fortification of low fat yoghurt treatments with MPP improved the viability of *Streptococcus thermophiles, Lactobacillus acidophilus* and *Bifidobacterium bifidum* . Similar results were reported by Phuapaiboon *et al*. (2013) who found that fortification of yoghurt with pineapple enhanced the probiotic viability during storage period. Also, Elsanhoty and Ramadan.,(2017) ,found that addition of barley β-glucan to probiotic low fat yoghurt enhanced the probiotic viability during storage.

Sensory evaluation of low fat yoghurt fortified with mango pulp fiber waste powder:

From results illustrated in Table (6). It could be seen that, the control low fat yoghurt (C1) showed the lowest scores for organoleptic properties, while fortification of low fat yoghurt with MPP improved the organoleptic properties of low fat yoghurt treatments and this improvement was proportional to the MPP fortification ratio, low fat yoghurt fortified with 3 % MPP gained the highest scores for organoleptic properties. The Organoleptic properties of all yoghurt treatments decreased as storage period progressed. A similar observation was found by Al-hamdani *et al* (2015), who found that fortification of yogurt with lupine flour improved the sensory scores of low fat yoghurt .Also Atwaa and Elmaadawy (2019) observed that fortification of low fat yogurt with 3 % garden cress seed powder improved the sensory scores of low fat yoghurt.

Table 6. Sensory evaluation of low fat yoghurt fortified with mango pulp fiber waste powder during storage at refrigerator temperature (5 ± 1˚C) for 15 day

Parameters	Storage period (Day)	Treatments C	C_1	T_1	T_2	T_3
Appearance (10)	Fresh	9.00±0.25^a	7.20±0.22^e	7.70±0.20^d	7.90±0.18^c	8.20±0.24^b
	5	8.90±0.20^a	7.00±0.18^e	7.40±0.25^d	7.70±0.24^c	8.00±0.20^b
	10	8.40±0.20^a	6.70±0.24^e	7.20±0.18^d	7.50±0.22^c	7.70±0.25^b
	15	8.00±0. 18^a	6.00±0.25^e	6.70±0.25^d	7.00±0.25^c	7.40±0.25^b
Flavour (60)	Fresh	58.50±1.20^a	52.50±1.44^d	54 .50±1.28^c	54.50±1.33^c	56.50±1.42^b
	5	57.50±1.24^a	52.50±1.30^d	53.50±1.33^c	54.50±1.25^c	56.50±1.28^b
	10	55.50±1.36^a	51.50±1.28^d	53.50±1.20^c	54.50±1.40^c	55.50±1.30^b
	15	53.50±1.40^a	48.50±1.34^d	51.50±1.42^c	51.50±1.36^c	52.50±1.25^b
Body& texture (30)	Fresh	29.50±0.35^a	22 .50±0.56^e	25.50±0.48^d	27.50±0.50^c	28.50±0.45^b
	5	29.00±0.42^a	22.50±0.50^e	25.50±0.36^d	27.50±0.38^c	28.50±0.33^b
	10	26.50±0.50^a	21.50±0.36^e	22.50±0.52^d	25.50±0.44^c	26.50±0.40^b
	15	25.50±0.38^a	20.50±0.44^e	21.50±0.48^d	23.50±0.50^c	25.50±0.52^b
Total (100)	Fresh	97.0±1.42^a	82.20±1.22^e	87.70±1.28^d	89.90±1.25^c	93.20±1.33^b
	5	95.60±1.25^a	82.00±1.44^e	86.40±1.36^d	89.70±1.33^c	93.0±1.28^b
	10	90.60±1.33^a	79.70±1.36^e	86.20±1.30^d	89.50±1.40^c	89.70±1.42^b
	15	86.40±1.28^a	76.00±1.40^e	82.70±1.42^d	83.50±1.28^c	85.40±1.34^b

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

CONCLUSION

Mango pulp fiber waste showed strong antioxidant capacity and high content of dietary fiber. Therefore, mango pulp fiber waste powder could be used as a source of bioactive components and dietary fiber in manufacture of low fat yoghurt which enhanced its physicochemical, microbiological antioxidant and sensory properties.

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الخصائص الفيزوكيميائية والميكروبيولوجية والحسية لليوجورت الحيوي منخفض الدهن المدعم بمخلفات ألياف لب المانجو كمصدر للألياف الغذائية

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تم دراسة تأثير تدعيم اليوجورت الحيوي منخفض الدهن بمسحوق مخلفات ألياف لب المانجو على الخواص الفيزوكيميائية والميكروبيولوجية والحسية. حيث تم إضافة مسحوق مخلفات ألياف لب المانجوالي اللبن منخض الدهن (1% دهن) المستخدم في صناعة اليوجورت بنسب 1 و 2 و 3٪. وتم تحليل اليوجورت المصنع خلال فترة الطزاجة وبعد مرور 5 و 10 و 15 يوم من التخزين علي درجة حرارة 5 ± 1 درجة مئوية من حيث الخصائص الفيزوكيميائية والميكروبيولوجية والحسية. وأظهرت النتائج أن تدعيم اليوجورت منخض الدهن بمسحوق مخلفات ألياف لب المانجو زاد من قيم المواد الصلبة الكلية. البروتين ، الرماد ، الأس الهيدروجيني ، الألياف الغذائية ، اللزوجة ، محتوي الفينولات الكلية والنشاط المضاد للأكسدة وكانت هذه الزيادات متناسبة مع نسبة التدعيم بمسحوق مخلفات ألياف لب المانجو. من ناحية أخرى ، انخفضت نسبة الحموضة ومعدل انفصال الشرش مع زيادة نسبة مسحوق مخلفات ألياف لب المانجو. كما أن تدعيم اليوجورت منخفض الدهن بمسحوق مخلفات ألياف لب المانجو أدى إلى تحسين حيوية *Streptococcus thermophiles* و *Lactobacillus acidophilus* و *Bifidobacterium bifidum* وكان هذا التحسن متناسبًا مع نسبة التدعيم بمسحوق مخلفات ألياف لب المانجو . ومن حيث الخصائص الحسية فقد أعطي اليوجورت المنخفض الدهن المحتوي علي 3٪ من مسحوق مخلفات ألياف لب المانجو على أعلى معدلات التحكيم الحسي مقارنة بمعاملات اليوجورت منخفض الدهن الأخري. وبالتالي ، توضح الدراسة أن مسحوق مخلفات ألياف لب المانجو يمكن استخدامه بمعدل 3 % كمصدر للمكونات النشطة بيولوجيًا والألياف الغذائية في صناعة اليوجورت منخفض الدهن حيث حسنت هذه الاضافة من خصائصه الفيزوكيميائية والمضادة للأكسدة والميكروبيولوجية والحسية.