Effect of Replacing Skim Milk Powder by Sweet Lupine Powder on Characteristics of Zebda-Mango Yoghurt Drink

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Abstract: Replacement of skim milk powder (SMP) by 0, 10, 20, 30 and 40% sweet lupine powder was studied on characteristics of Zebda-mango yoghurt drinks. Full fat-mango yoghurt drink was applied as a control treatment for comparison. In general, the gradual increase of replacing SMP by sweet lupine powders in mango yoghurt drinks were exhibited significant ($p<0.05$) increases in protein, fat and fiber contents, acidity, total phenolic compounds (TPC), antioxidant activity (AA), apparent and plastic viscosities, yield stress and consistency coefficient as compared with control sample. On the other hand a significant ($p<0.05$) decreases were observed for total solids, protein, fat and vitamin C contents, pH values, TPC and AA, flow behaviour index and water binding capacity (WBC) at the refrigerator storage proceeding. The sensory evaluation of 20 and 30% sweet lupine based yoghurt drinks was ranked high scores than low fat control sample. During the storage times no significant ($p<0.05$) differences observed in the first week, while a significant ($p<0.05$) decreases obviously noticed for all panelists' scores in the second week. The reduction in production cost of products was observed with the increase of lupine powder levels, but the best cost of production at 30% sweet lupine powder was defined according to the sensory evaluation.

Keywords**:** Cost of production; Sensory evaluation; Sweet lupine powder; Zebda-mango yoghurt drink.

INTRODUCTION

Yoghurt drink is categorized as stirred yoghurt, low viscosity and consumed as a refreshing yoghurt drink; in addition the chemical composition of yoghurt drink varies between countries (Tamime and Robinson, 2000). According to Food and Drug Administration, yoghurt drink > 8.25% milk solid not fat (MSNF), moreover free fat yoghurt drink < 0.5% fat, low fat yoghurt drink 2% fat, yoghurt drink > 3.25% fat and the pH values of yoghurt drinks were ranged from 4.0 - 4.5 (Chandan *et al.,* 2006). According to Tamime and Robinson, (2000), the gross chemical composition of yoghurt drink (g / 100 g) was 3.5% fat, 3.8% protein, 8% sugar and 15% sterile fruit. Indeed, the fortification of yoghurt by different fruits has been increased the consumer demand (Erdogan and Zekai, 2003), therefore its possible to use different fruits in yoghurt drinks such as apple concentrates, carrot, lemon, orange concentrates, pineapple, raspberry and strawberry (Tamime and Robinson, 2000). Mango (*Mangifera indica*) is a delicious fruit and characterized a king of fruits (Anonymous, 2014). Raut *et al.* (2015) evaluated of yoghurt drinks by 3, 6 and 9% mango pulp, and they reported the highest sensory scores was 6% mango pulp-based yoghurt drink.

In a series of previous studies, Bylund, (1995) classified of yoghurt drinks to 1) homogenized stirred yoghurt, followed by cool and the shelf life ranged from 2 to 3 weeks. 2) homogenized stirred yoghurt, followed by pasteurized and the shelf life from 1 to 2 months. 3) homogenized stirred yoghurt, followed by UHT and the shelf life up to several months. The whey off was considered a problem in yoghurt drink, therefore the incorporation of stabilizer into yoghurt drink was essential (Foley and Mulcahy, 1989; Tuohy, 1990). Moreover, the syneresis was lacked in a cultured beverage when using carboxylmethyl cellulose (CMC) or gelatin (Chopra and Gandhi, 1990).

Lupines belong to families of Fabaceae, Geniteae or Leguminosae (Pastor *et al*., 2009). Genus of lupine have more than four hundred species, and four from their represented as sweet lupine (Wasche *et al*., 2001). Lupine seeds are a good source for protein, lipids, fiber, minerals and vitamins (Zielinska *et al*., 2008). Also, lupine seeds are higher in each soluble sugars and soluble non starch polysaccharides (Erbas *et al.*, 2005). Furthermore, proteins of lupine seed characterized a good in water and fat absorption capacities, also has an emulsifying and foaming capacity (Hojilla *et al*., 2004). The previous results mentioned that the health of lupine powder such as control blood sugar, diabetes, eczema, hemorrhoid, improve bowel health, liver disorder, reduce blood pressure, reduce blood cholesterol and suppresses appetite (Baser *et al*., 1986; Baytop 1999, Abdel-Salam *et al*., 2015). In addition, the lupine powder provides functional properties in preparation of yoghurt-like product (De Cortes Sánchez *et al*., 2005). Therefore, the present study aimed to evaluate the effect of partial replacing of skim milk powder by sweet lupine powder on the characteristics of Zebda-mango yoghurt drinks.

MATERIALS AND METHODS

Materials

Mango fruit (*Mangifera indica* L.) cv. Zebda, sweet lupine seeds (*Lupinus termis*) and white sugar were obtained from the local market. Fresh cream (55% fat, 4.05% MSNF) was obtained from the pilot Plant of Dairy Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. SMP (1.3% fat, 34% protein, 52% lactose, 8% minerals and 3% water) was imported from France and obtained from the local market. YoFlex ® Express 1 (200 U) (*Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus*) was purchased from Christian Hansen

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laboratories, Denmark. All chemicals used in the present study were of analytical grade.

Methods

Preparation of sweet lupine powder

The sweet lupine seeds were washed by tap water, soaked in water for 12 hrs. The hydrated lupine seeds were boiled at 85 °C/ 15 min., then soaked again in tap water for 5 days and the water was changed every 8 hrs, followed by dehulling of sweet lupine seeds. Drying of dehulled lupine seed was achieved at 70 °C for 12 hrs, followed by milling using electric blender. The obtained ground solids were sieved to obtain the fine lupine powder, then packed in sealed bags and kept in the refrigerator until used. The chemical compositions of resultant lupine powder are tabulated in Tale (1).

Preparation of Zebda-mango pulp

Zebda-mango fruit were washed with tap water and mango peel was removed. By knife the pulp of mango cut into small pieces, then homogenized using blender, followed by packing in sealed bags and kept at - 18 °C until used. The chemical compositions of mango pulp are reported in Tale (1).

Table (1): Chemical composition of Zebda-mango pulp and sweet lupine powder

Chemical composition	Zebda-mango pulp▼	Sweet lupine powder▼
Moisture %	80.85	5.86
Fat %	0.75	6.35
Protein %	0.32	41.55
Ash %	0.42	4.36
Crude fibers %	4.05	2.65
Vitamin C (mg /100 g)	36.75	4.45
Antioxidant activity (%)	46.75	55.64
Total phenolic compounds (mg Gallic acid /100 g)	92.25	195.25

▼, mean values

Preparation of sweet lupine powder based-mango yoghurt drink

The formulations of full and low fat mango yoghurt drink are shown in Table (2). Controls of T1 and T2 represented as full and low fat mango yoghurt drinks, and prepared from SMP, fresh cream, sugar, CMC, Zebda-mango pulp and filtered water. The SMP of T3, T4, T5 and T6 was replaced by sweet lupine powder with rates of 10, 20, 30 and 40%. Both SMP and sweet lupine powder were reconstituted in the two-thirds of the filtered water, pasteurized at 85°C for 10 min and cooled to 42°C., then inoculated by starter culture (2.8 g /100 kg) and the mixtures were incubated at 42°C for 3 hrs.

Both 8% sugar and 0.3% CMC was dissolved in the remained third of filtered water, pasteurized at 85°C for 10 min., cooled to 5°C and kept in the refrigerator until used. Set yoghurt, sugar syrup and 10% Zebda-mango pulp were mixed together using electric blender for 10 min to obtain the flavoured yoghurt drink, then packed in plastic cups (100 ml) and storage in the refrigerator at 5°C until analysed.

Table (2): Formulations of sweet lupine powder based-mango yoghurt drink

Ingredients	The ingredients▼ / 100 Kg					
	T1*	T2**	T3	T4	T5	T6
SMP (Kg)	10.12	12	10.80	9.60	8.40	7.20
Fresh cream (Kg)	3.09	-	-	-	-	-
Sweet lupine powder (Kg)	-	-	1.20	2.40	3.60	4.80
White sugar (Kg)	8	8	8	8	8	8
CMC (Kg)	0.30	0.30	0.30	0.30	0.30	0.30
Zebda-mango pulp (Kg)	10	10	10	10	10	10
Filtered water (Kg)	77.87	77.87	77.87	77.87	77.87	77.87
Starter culture (Kg)	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028

▼, Mean values; *, **, Controls

Analytical methods

Sweet lupine powder and Zebda-mango pulp were analysed for moisture, fat, protein, fiber and ash (AOAC, 2000). SMP and lupine based-mango yoghurt drinks were analysed for total solids, protein, fat, fiber, ash, and acidity according to method of AOAC, (2000). Ascorbic acid was determined according to method of Osborne and Voogt (1978). The pH values of samples were measured using a digital pH meter (Jenway electrode no. 3505, Dunmow, England). The radical scavenging activity of samples was measured by DPPH as described by Kadhum *et al*. (2011) and the total phenolic compounds were determined by Folin-Ciocalteau reagent as described by Samovar *et al*. (2014).

Water binding capacity

The WBC of all treatments was determined using method of Remeuf *et al*. (2003). Sample of 20 g was centrifuged at 483 × □ / 10 min / 20 °C. The whey layer was removed and then weighed. WBC (%) = 100 (sample weight □ whey weight) / sample weight.

Rheological measurements

The rheological parameters of sweet lupine-enriched mango yoghurt drink were measured at 10 °C using a Brookfield viscometer (Brookfield Engineering Laboratories, USA), equipped with a Sc4-21 spindle running at 10 rpm.

Sensory attributes

The sensory evaluation of lupine powder based-mango yoghurt drink was determined according to Pal and Gupta (1985). Ten panelists judged of the different treatments using parameters of flavour (45), body & texture (30), appearance (15) and colour (10).

Cost of production

Production costs of all treatments were calculated according to prices of materials used in flavoured yoghurt drink manufacture in the Egyptian market.

Statistical analyses

Results of lupine treatments were analyzed statistically by the two way analyses of variance using computer program software SAS (version 8 for Windows, USA). A Duncan analysis ($p<0.05$) was used to determine the differences between mean values of treatments.

RESULTS AND DISCUSSION

Composition of sweet lupine powder based-mango yoghurt drink

The compositions of lupine yoghurt drinks are tabulated in Table (3). Concerning total solids (TS) of sweet lupine powder based-mango yoghurt drink (SLMYD), no significant ($p<0.05$) differences observed between control of T1 (full fat) and control of T2 (low fat), this may be correlated to equal TS of two controls. In addition the increase of replacing SMP ratios by sweet lupine powder had no significant changes in the TS of T3 till T6 as compared to control of T2. Moreover, the TS of all treatments significantly ($p<0.05$) decreased throughout the refrigeration storage up to 14 days which can be explained by the decrease in other components / or due to the interaction between basic amino groups and lactose (Humphrey and Plunkett, 1969). Results of the present study are in line with that observed by Eman *et al*. (2015), they found that the TS of lupine powder based yoghurt decreased during the storage.

Protein content of T1 compared to T2 was less, whereas fat content of T1 was higher than T2 which can be explained by the difference in formulations of two controls (Table 2). The gradual increase in lupine powder ratios of treatments were caused statistically ($p<0.05$) increases in protein, fat and fiber contents due to richness of lupine powder from protein, fat and fiber contents (Table 1), moreover both protein and fat contents of samples had increased significant ($p<0.05$), whereas fiber content had no significant ($p<0.05$) differences throughout the refrigerator storage. Our results are in agreement with that observed by Tamime and Robinson (2007), they found that the decrease in protein percentage throughout storage was attributed to protein degradation by *Lactobacillus bulgaricus*. Also, the reduction in fat contents of treatments was explained by the lipolytic activity of microorganisms (Gunawardhana and Dilrukshi, 2016).

Both ash and vitamin C contents of lupine treatments were exhibited significant ($p<0.05$) decreases with the increase of lupine powder ratios. Throughout the storage times, a significant ($p<0.05$) increase was observed for ash content, whereas vitamin C content had decreased significant ($p<0.05$).

The pH values and acidities of lupine yoghurt drinks

The pH values and acidities of lupine mango yoghurt drink are listed in Table (4). As well known both acidity and pH values of treatments had an opposite trend. In addition, the pH values of lupine treatments were significantly ($p<0.05$) decreased while acidities increased with corresponding to the increase of sweet lupine levels, therefore the increase in acidities of lupine treatments were protein-dependent / or the relation between the increase of acidities and lupine protein levels was positive. Results of present work are in consistent with that reported by Abdel-Salam *et al*. (2015), who showed that the increase of lupine powder resulted the increase in acidities of lupine treatments which can attributed to malic acid production-dependant because of create by-products from homo fermentation process especially lactic acid (Fernandez-Garcia and McGregor, 1994). Nilufar (1999) found that the increase in acidities of mango yoghurt related to the increase of TS due to the buffering action of milk ingredients. The pH values of all treatments significantly ($p<0.05$) decreased whereas the acidities increased as the storage period proceeding due to conversion of lactose into lactic acid by lactic acid bacteria (Nuzhat *et al*., 2003).

Total phenolic compounds and antioxidant activity of lupine treatments

Fig. (1) (A and B) shows both TPC and AA values of lupine treatments were increased significantly ($p<0.05$) with the gradual increase of sweet lupine powder ratios due to containing of lupine powder high values from TPC and AA (refer to Table 1), moreover samples of T6 at 1 day exhibited a high TPC and AA values. Both TPC and AA of treatments were statistically ($p<0.05$) decreased with the progressing of refrigerator storage which can be explained by the decrease in both stability of TPC (Sagdic *et al*., 2012), and the enzymatic and chemical reactions (Turfan *et al*., 2012).

Table (3): Composition of sweet lupine based mango yoghurt drink

Treatments	Total solids %			Protein %		
	1 day	7 days	14 days	1 day	7 days	14 days
T1*	23.77±0.37^{Aa}	23.12±0.24^{Ba}	22.94±0.16^{Ba}	3.42±0.12^{Ae}	3.35±0.08^{ABe}	3.18±0.11^{Bd}
T2**	23.37±0.10^{Aa}	22.97±0.37^{ABa}	22.78±0.17^{Ba}	4.05±0.08^{Ad}	3.91±0.10^{ABd}	3.71±0.14^{Bc}
T3	23.72±0.22^{Aa}	23.15±0.33^{Ba}	21.92±0.12^{Ca}	4.20±0.10^{Acd}	4.07±0.07^{ABcd}	3.86±0.16^{Bbc}
T4	23.45±0.29^{Aa}	23.08±0.22^{ABa}	22.86±0.20^{Ba}	4.31±0.13^{Abc}	4.23±0.11^{Abc}	4.00±0.10^{Bab}
T5	23.31±0.26^{Aa}	22.96±0.35^{ABa}	22.74±0.14^{Bb}	4.46±0.11^{Ab}	4.38±0.10^{Aab}	4.10±0.13^{Ba}
T6	23.67±0.37^{Aa}	23.21±0.31^{Aa}	22.00±0.20^{Bb}	4.72±0.12^{Aa}	4.48±0.12^{Ba}	4.17±0.11^{Ca}
Treatments	**Fat %**			**Ash %**		
T1*	3.03±0.02^{Aa}	2.90±0.01^{Ba}	2.78±0.02^{Ca}	0.89±0.02^{Ac}	0.91±0.03^{Bc}	0.96±0.02^{Bc}
T2**	0.62±0.01^{Af}	0.55±0.02^{Be}	0.50±0.01^{Ce}	1.01±0.02^{Aa}	1.05±0.02^{ABa}	1.07±0.03^{Ba}
T3	0.68±0.02^{Ae}	0.61±0.01^{Bd}	0.56±0.02^{Cd}	0.98±0.03^{Aab}	1.03±0.01^{Aa}	1.06±0.01^{Bab}
T4	0.75±0.02^{Ad}	0.67±0.03^{Bc}	0.63±0.02^{Bc}	0.95±0.02^{Ab}	0.98±0.02^{Bb}	1.02±0.02^{Bb}
T5	0.82±0.01^{Ac}	0.77±0.02^{Bb}	0.73±0.03^{Bb}	0.84±0.01^{Ad}	0.86±0.03^{Ad}	0.95±0.03^{Bc}
T6	0.89±0.02^{Ab}	0.81±0.01^{Bb}	0.77±0.02^{Cb}	0.76±0.02^{Ae}	0.79±0.02^{ABe}	0.82±0.02^{Bd}
Treatments	**Fiber %**			**Vitamin C (mg / 100 g)**		
T1*	0.37±0.01^{Ae}	0.36±0.02^{Ae}	0.35±0.02^{Af}	1.83±0.04^{Aabc}	1.70±0.02^{Bab}	1.52±0.03^{Ca}
T2**	0.39±0.02^{Ae}	0.38±0.02^{Ae}	0.40±0.01^{Ae}	1.89±0.03^{Aa}	1.74±0.04^{Ba}	1.59±0.07^{Ca}
T3	0.60±0.02^{Ad}	0.61±0.03^{Ad}	0.63±0.03^{Ad}	1.84±0.06^{Aab}	1.70±0.03^{Bab}	1.52±0.04^{Ca}
T4	0.88±0.01^{Ac}	0.88±0.02^{Ac}	0.91±0.03^{Ac}	1.80±0.03^{Abc}	1.66±0.02^{Bb}	1.44±0.03^{Cb}
T5	1.07±0.04^{Ab}	1.05±0.04^{Ab}	1.04±0.02^{Ab}	1.79±0.04^{Abc}	1.59±0.03^{Bc}	1.39±0.02^{Cbc}
T6	1.18±0.03^{Aa}	1.17±0.03^{Aa}	1.19±0.03^{Aa}	1.76±0.03^{Ac}	1.55±0.02^{Bc}	1.34±0.03^{Cc}

Means of treatments with unlike capital or small superscripts within row or column respectively are significantly different ($p<0.05$); *, **, controls.

Table (4): The pH values and acidities of lupine mango yoghurt drinks

Treatments	pH values			Acidity %		
	1 day	7 days	14 days	1 day	7 days	14 days
T1*	4.54±0.04^{Abc}	4.41±0.05^{Bcd}	4.28±0.02^{Cbc}	0.77±0.03^{Ce}	0.92±0.01^{Be}	1.11±0.03^{Ad}
T2**	4.48±0.06^{Ac}	4.36±0.03^{Bd}	4.20±0.05^{Cd}	0.84±0.02^{Cd}	0.99±0.03^{Bd}	1.20±0.04^{Ac}
T3	4.61±0.03^{Aa}	4.50±0.03^{Ba}	4.38±0.05^{Ca}	0.88±0.01^{Ccd}	1.02±0.02^{Bcd}	1.22±0.02^{Abc}
T4	4.58±0.02^{Aab}	4.47±0.02^{Bab}	4.33±0.03^{Cab}	0.91±0.03^{Cbc}	1.05±0.03^{Bbc}	1.27±0.03^{Ab}
T5	4.57±0.03^{Aab}	4.43±0.03^{Bbc}	4.28±0.02^{Cbc}	0.94±0.03^{Cb}	1.08±0.02^{Bb}	1.33±0.02^{Aa}
T6	4.53±0.04^{Abc}	4.40±0.02^{Bcd}	4.26±0.04^{Ccd}	1.02±0.04^{Ca}	1.14±0.03^{Ba}	1.37±0.03^{Aa}

See footnote Table (3)

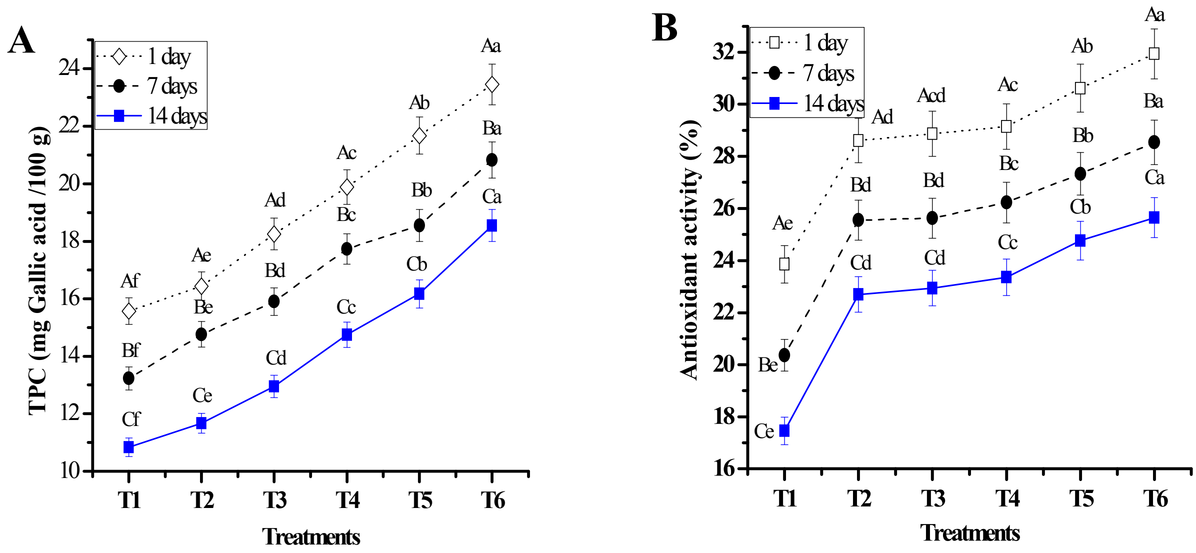

Fig. (1): Total phenolic compounds (A) and antioxidant activity (B) of lupine treatments
Capital or small letters within same or different treatments respectively are significantly different (p<0.05)

Rheological measurements

Table (5) shows control of T1 as compared to control of T2 gained a high apparent and plastic viscosities, yield stress and consistency coefficient due to the differences in their fat contents. Also, the apparent and plastic viscosities, yield stress and consistency coefficient of lupine treatments appeared significant ($p<0.05$) increases with the gradual increase in sweet lupine powder, which probably attribute to the increase of protein content. Akalın *et al.* (2012) reported that the control of probiotic yoghurt recorded less firm owing of the low protein content. The flow behavior index of treatments was exhibited an opposite trend for the foregoing parameters. Concerning the storage periods, the rheological parameters showed that a significant ($p<0.05$) increases due to the solidification of gel structure and thixotropy of yoghurt drinks (Gomes *et al.*, 2013; Wang *et al.*, 2012).

Water binding capacity of lupine treatments

Fig. (2) shows the WBC of T1 gained a high whey-retention than T2 presumably due to the directly relation between fat content and WBC. Fortification of T3 □ T6 by 10 – 40% lupine powder corresponds to the increase in WBC of SLMYD which can be explained by a high of WBC for lupine powder than SMP. Our results are matched with that observed by Khalid and Elharadallou, (2013), they showed that the WBC of lupine flour was 1.34 mL H_2O /g protein, whereas Wong and Kitts, (2003) found that the WBC of nonfat dry milk was 0.55 g H_2O / g protein. A significant ($p<0.05$) decreases in the WBC of all mango yoghurt drinks throughout the storage days were observed.

Sensory attributes of lupine powder base yoghurt drinks

Table (6) shows full fat control (T1) compared to low fat control (T2) ranked higher scores in flavour and body & texture; moreover the appearance and colour scores of two controls were comparable. As well known the beany flavour was related with the lupine-based yoghurts (Karleskind *et al.*, 1991), thus the present study improved this problem by combining of fermentation and flavouring processes together in lupine mango yoghurt drinks. Jiménez-Martínez *et al.* (2003) showed that the beany flavour in lupine yoghurt corrected by the resultant acidity. The flavour scores of T3 till T5 had a significant ($p<0.05$) increases than T2, while the beany flavour was appeared with sample of T6, moreover samples of T4 and T5 were acquired the best treatments through panelists' scores. Abdel-Salam *et al.* (2015) illustrated that 8% lupine powder based yoghurt obtained a high score during the storage from fresh to 7 days, whereas 2% lupine yoghurt occupied a better flavour after control sample. Throughout the storage days, no changes in flavour scores of all treatments was occurred from 1 to 7 days, whereas after 7 days up to 14 days a significant ($p<0.05$) decreases in flavour scores was observed.

Body & texture scores of T3 – T5 were exhibited a significant ($p<0.05$) increases, while sample of T6 recorded a substantial ($p<0.05$) decrease as compared to T2, in addition sample of T5 ranked a high sensory evaluation scores. The progressing in storage periods of treatments affected the body & texture through the second week. The appearance and colour of lupine treatments except T6 didn't change with lupine powder levels; in addition the panelists' scores of appearance and colour significantly ($p<0.05$) decreased during the storage especially from 7 – 14 days. It could be noted that, the sensory evaluation of all treatments were significantly ($p<0.05$) decreased as the storage periods proceeding due to the development of acidity /or the resultant of microbial metabolism (El-Nagar and Brennan, 2001; Ibrahim *et al.*, 2003).

Table (5): Rheological measurements of sweet lupine-enriched mango yoghurt drink

Rheological properties	Storage	T1*	T2**	T3	T4	T5	T6
Plastic viscosity (mPa.s)	1 day	37.32±0.38^{Ca}	26.10±0.54^{Cf}	30.98±0.27^{Ce}	32.42±0.15^{Cd}	33.22±0.18^{Cc}	35.62±0.44^{Cb}
	7 days	39.32±0.23^{Ba}	27.95±0.47^{Bf}	32.17±0.16^{Be}	34.14±0.33^{Bd}	35.54±0.28^{Bc}	37.23±0.25^{Bb}
	14 days	41.17±0.11^{Aa}	30.06±0.25^{Af}	34.46±0.22^{Ae}	36.80±0.17^{Ad}	38.06±0.31^{Ac}	39.93±0.46^{Ab}
Apparent viscosity (mPa.s)	1 day	204.02±2.87^{Aa}	95.89±0.87^{Af}	110.46±1.75^{Ae}	136.44±1.83^{Ad}	145.68±2.05^{Ac}	185.85±2.47^{Ab}
	7 days	209.02±1.52^{Ba}	99.67±1.12^{Bf}	116.55±1.26^{Be}	142.82±1.74^{Bd}	152.27±1.47^{Bc}	191.63±1.15^{Bb}
	14 days	216.02±1.65^{Ca}	108.67±1.05^{Cf}	123.35±1.35^{Ce}	148.14±1.18^{Cd}	159.55±1.76^{Cc}	198.03±1.26^{Cb}
Yield stress (N/m^2)	1 day	3.05±0.07^{Aa}	1.24±0.05^{Af}	1.43±0.08^{Ae}	1.70±0.06^{Ad}	2.10±0.10^{Ac}	2.54±0.11^{Ab}
	7 days	3.63±0.10^{Ba}	1.43±0.07^{Bf}	1.77±0.11^{Be}	1.95±0.08^{Bd}	2.56±0.07^{Bc}	2.90±0.10^{Bb}
	14 days	3.91±0.05^{Ca}	1.73±0.08^{Cf}	1.96±0.06^{Ce}	2.13±0.05^{Cd}	2.87±0.08^{Cc}	3.23±0.07^{Cb}
Consistency coefficient (mPa.s)	1 day	60.15±0.33^{Ca}	21.78±0.14^{Cf}	26.99±0.17^{Ce}	32.73±0.21^{Cd}	39.11±0.11^{Cc}	50.26±0.45^{Bb}
	7 days	62.21±0.26^{Ba}	23.55±0.18^{Bf}	29.05±0.24^{Be}	36.16±0.61^{Bd}	41.33±0.66^{Bc}	52.91±0.27^{Ab}
	14 days	63.90±0.55^{Aa}	25.04±0.35^{Af}	31.10±0.17^{Ae}	38.62±0.32^{Ad}	43.07±0.37^{Ac}	53.28±0.24^{Ab}
Flow behaviour index	1 day	0.97±0.03^{Ad}	1.45±0.06^{Aa}	1.41±0.05^{Aa}	1.26±0.04^{Ab}	1.16±0.02^{Ac}	1.05±0.04^{Ad}
	7 days	0.90±0.04^{ABe}	1.39±0.05^{ABa}	1.38±0.03^{ABa}	1.22±0.02^{ABb}	1.11±0.04^{ABc}	1.00±0.03^{ABd}
	14 days	0.86±0.05^{Bd}	1.34±0.03^{Ba}	1.32±0.04^{Ba}	1.17±0.03^{Bb}	1.06±0.02^{Bc}	0.94±0.05^{Bd}

Means of treatments with unlike capital or small superscripts within column or row respectively are significantly different ($p<0.05$); *, **, controls.

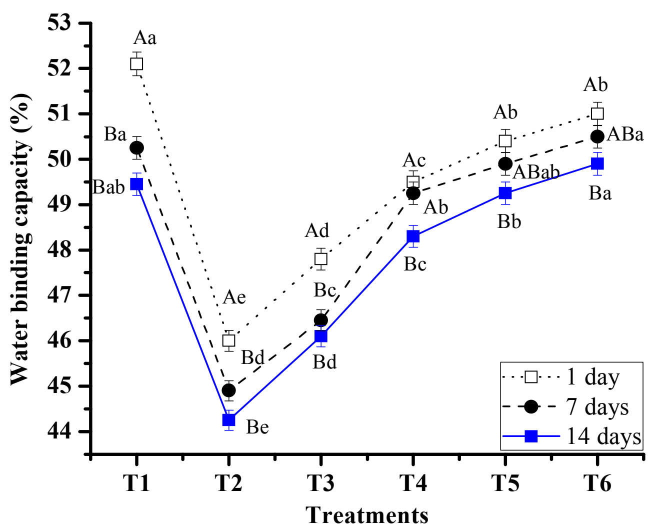

Fig. (2): Water binding capacity of lupine powder mango yoghurt drinks
See footnote Fig. (1)

Table (6): Sensory evaluation of lupine mango yoghurt drink

Treatments	Flavour (45)			Body & texture (30)		
	1 day	7 days	14 days	1 day	7 days	14 days
T1*	43.35±0.42^{Aa}	42.95±0.37^{Aa}	40.96±0.50^{Ba}	29.11±0.23^{Aa}	28.87±0.18^{Aa}	27.67±0.10^{Ba}
T2**	40.27±0.28^{Ad}	40.14±0.44^{Ac}	39.32±0.41^{Bc}	27.77±0.17^{Ac}	27.63±0.21^{Ac}	26.15±0.34^{Bc}
T3	41.55±0.15^{Ac}	41.07±0.26^{Ab}	39.11±0.35^{Bc}	27.84±0.31^{Ac}	27.77±0.12^{Ac}	26.65±0.27^{Bb}
T4	42.82±0.57^{Aab}	42.44±0.48^{Aa}	40.17±0.18^{Bb}	28.56±0.15^{Ab}	28.35±0.30^{Ab}	27.33±0.15^{Ba}
T5	42.54±0.62^{Ab}	42.60±0.17^{Aa}	40.15±0.22^{Bb}	28.73±0.28^{Aab}	28.84±0.16^{Aa}	27.70±0.13^{Ba}
T6	38.17±0.35^{Ae}	37.45±0.64^{Ad}	34.82±0.55^{Bd}	27.61±0.24^{Ac}	26.76±0.21^{Bd}	25.35±0.17^{Cd}
Treatments	**Appearance (15)**			**Colour (10)**		
T1*	14.45±0.10^{Aa}	14.36±0.13^{Aa}	13.88±0.12^{Ba}	9.76±0.10^{Aa}	9.60±0.11^{Aa}	8.86±0.12^{Ba}
T2**	14.24±0.12^{Aab}	14.11±0.14^{Ab}	13.72±0.10^{Bab}	9.64±0.07^{Aa}	9.55±0.10^{Aa}	8.77±0.13^{Ba}
T3	14.35±0.14^{Aa}	14.15±0.11^{Aab}	13.77±0.17^{Bab}	9.60±0.11^{Aab}	9.48±0.07^{Aab}	8.72±0.10^{Ba}
T4	14.40±0.10^{Aa}	14.24±0.08^{Aab}	13.71±0.14^{Bab}	9.65±0.06^{Aa}	9.53±0.12^{Aab}	8.74±0.13^{Ba}
T5	14.25±0.15^{Aab}	14.15±0.12^{Aab}	13.65±0.16^{Bab}	9.45±0.13^{Abc}	9.35±0.11^{Abc}	8.65±0.12^{Ba}
T6	14.11±0.13^{Ab}	14.04±0.14^{Ab}	13.56±0.10^{Bb}	9.35±0.10^{Ac}	9.23±0.13^{Ac}	8.06±0.11^{Bb}

See footnote Table (3)

Cost of production

The costs of yoghurt drinks are shown in Table (7). The total costs of T1 were higher than T2 because of the variation between two treatments in each fat content and SMP, furthermore the replacing of SMP by sweet lupine powder was caused a substantial reduction in costs of lupine treatments as the following order of T6>T5>T4>T3>T2. Therefore, from the viewpoint economical and the sensory evaluation, we can say the sweet lupine powder has been considered a good substitute for SMP in flavoured yoghurt drinks at limited levels.

CONCLUSION

The fortification of Zebda-mango yoghurt drinks by different levels from sweet lupine powder led to obviously changes in chemical, physiochemical, rheological and sensory evaluation of treatments, in addition the production cost of products decreased with the increase of lupine powder, therefore the incorporation of sweet lupine powder in mango yoghurt drinks considered a good source from the viewpoint of economical and nutritional.

Table (7): Cost production of lupine mango yoghurt drinks

Item	T1*	T2**	T3	T4	T5	T6
Total cost of production (EGP)	1277.45	1252.56	1190.16	1127.76	1065.36	1002.96
% Reduction of cost as compared to T1	□	1.95	6.83	11.72	16.60	21.49

*, **, controls

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تأثير استبدال اللبن الفرز المجفف بمسحوق الترمس الحلو علي خصائص مشروبات اليوغورت المطعمة بمانجو الزبدة

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تمت دراسة استبدال اللبن الفرز المجفف بنسب متفاوته من مسحوق الترمس الحلو (٠ ، ١٠ ، ٢٠ ، ٣٠ و٤٠%) علي خصائص مشروبات اليوغورت المطعمة بمانجو الزبدة. أدي استبدال اللبن الفرز المجفف بمسحوق الترمس الحلو الي زيادة معنوية في محتويات البروتين ، الدهن ، الالياف ، الحموضة ، مركبات الفينول ، النشاط المضاد للتأكسد ، اللزوجة الظاهرية والبلاستيكية ، اجهاد الخضوع ، معامل التماسك مقارنة بالكنترول. علاوة علي ذلك فان قيم الجوامد الكلية ، البروتين ، الدهن ، فيتامين ج ، الاس الهيدروجيني ، مركبات الفينول ، النشاط المضاد للتأكسد ، معامل التدفق ، قدرة الارتباط الماء أظهرت انخفاضا معنويا خلال فترة التخزين. أظهرت نسب ٢٠ و ٣٠% مسحوق الترمس أعلي قيم حسية مقارنة بالكنترول المنخفض الدهن ، اضافة الي ذلك فان كل الصفات الحسية لمشروبات اليوغورت المطعمة اظهرت انخفاضا معنويا خاصة خلال الاسبوع الثاني من التخزين. لوحظ أن تكاليف انتاج مشروبات اليوغورت المطعمة انخفضت بزيادة نسب الاستبدال ببودر الترمس الحلو ، الا أن افضل المعاملات انخفاضا في تكاليف الانتاج تم تحديدها وفقا للخصائص الحسية.