Journal of Food and Dairy Sciences

Journal homepage: www.jfds.mans.edu.eg
Available online at: www. jfds.journals.ekb.eg

Functional Properties and Acceptability of Ice Soy Milk Fortified with Papaya or Kiwi

Rokaia R. Abdelsalam[1*]; Maha M. Bikheet[2] and A. S. Zahran[2]

[1]Department of Food Science, Faculty of Agriculture, Minia University.
[2]Department of Dairy Science, Faculty of Agriculture, Minia University.

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ABSTRACT

Lactose-free products are still not suitable for people who suffer from food allergy. Therefore, the present investigation was carried out to enhance the functional properties of ice soy milk fortified with different percentage of fresh kiwi (FK) and papaya (FP) at (5%, 10% and 15%) as well as a powder (KP and PP) at 0.5%, 1% and 1.5%. Fortifications led to an increment of the total flavonoids content to 40% with FP and 69% with FK, total phenols (20% and 35%) and tannins (36% and 60%) in FK and FP ice soy milk compared to control, respectively. Using citric acid before drying led to a loss of total phenols, flavonoids and tannins content by only 13%, 16% and 27%, respectively. Carotenoids were found to be at the highest level in ice soy milk with 15%FP in comparison to PP1.5% and FK15%. On the other hand, incorporation of kiwi or papaya powder causes decrements in overrun value. Ice soy milks were considered microbiologically safe. A high positive significant correlations were observed between ice soy milk bioactive components and DPPH, TP($r=0.638$,P<0.01), tannins($r=0.673$,P<0.01) and TF($r=0.727$,P<0.01), as well as it had a negative significant correlation with NEB($r=-0.823$,P<0.01) and yellow flavonoid($r=-0.829$,P<0.01). The 'b' value was increment with increased percentage of fresh fruits and had a significant strong correlation with carotenoids($r=0.943$,P<0.01), TP($r=0.871$,P<0.01) and tannin($r=0.818$,P<0.01). Ice soy milk produced with FK 15% as well as FP 10% could be used as a healthy acceptable frozen product especially people who suffer from lactose intolerance and food allergy syndromes.

Keywords: ice soy milk- functional properties- bioactive components -DPPH - lactose intolerance- food allergy.

INTRODUCTION

Soy milk has been reported to have about 60 to 90 % nutritional value of cow's milk. It has an equivalent nutritional value of cow's milk with the addition of a small amount of sulfur amino acids. Moreover, it has high protein digestibility and free content of gluten as well as lactose (Khodke *et al*., 2014 and Ugochi and Chukwuma, 2015). It contains 1.3 g of fiber, no cholesterol. Soy milk has lower calories (44 calories/100 g portion) compared to cow's milk (61 calories/100 g portion), which has zero fiber, and 14mg/100g of cholesterol. Therefore, it is considered as an important healthy drink for people who are allergic to cow's milk proteins or suffer from lactose intolerance. The number of these people is spreading in most of the world, with wide variation between different regions and an overall frequency of around two-thirds of the world's population (Storhaug *et al*., 2017). Soy milk is also suitable and recommended for diabetic people (Laan and Truelsen, 2009 and Bisla *et al*., 2012).

Papaya (*Carica papaya*) is the third-largest grown tropical fruit worldwide (Evans & Ballen, 2012). It is traditionally used as a therapeutic remedy due to its medicinal properties. Nutritionally, the edible portion has a good source of carotenoids, vitamin C, thiamine, riboflavin, niacin, vitamin B6, vitamin K and rich in phytochemicals (Ikram *et al*., 2015 and Ovando-Martinez *et al*., 2018)). It contains both macro and micro minerals. The bioavailability of carotenoids found in papaya has been reported as being better in comparison to their counterparts (Schweiggert *et al*., 2014).

Kiwi's (*Actinidia deliciosa*) have become extremely popular in the past two decades due to their various medicinal properties. It has vitamins (A, E, K), minerals, phenols, β-carotene, lutein, and flavonoids. It also contains lots of glucose and fructose and a small amount of sucrose. Kiwi plays an important part in our daily routine because it has naturally more potassium than a banana or citrus fruits (Wojdyło, *et al*., 2017). In addition, kiwi fruit's enhance health care effects, e.g., anti-cancer isoflavones, organic acids, polysaccharide, and antimicrobial activity (Pham *et al*., 2019).

The consumption of plant-based milk substitutes has spread rapidly worldwide due to its numerous positive effects on the health of the human body. Despite the added sugar and the lack of total protein content, phenolic compounds, unsaturated fatty acids, antioxidant activity, and bioactive compounds such as phytosterols and isoflavones make plant-based milk substitutes an excellent choice as functional foods (Aydar *et al*., 2020). Thus the challenge in this study was to obtain highly nutritious and acceptable ice soy milk for lactose intolerance people. So, the objectives of this study were:

[*] Corresponding author.
E-mail address: rokaia.guaid@minia.edu.eg
DOI: 10.21608/jfds.2020.106368

1. To prepare natural functional ice soy milk incorporated with fresh or dried papaya as well as kiwi.
2. To study the acceptability of the ice soy milks fortified with papaya or kiwi.

MATERIAL AND METHODS

Material

Soybean (Giza 80) was obtained from the Agriculture Administration, Minia Governorate; Papaya fruit (*Carica papaya*) was obtained from the Department of Plant Protection, Faculty of Agriculture, Minia University. Kiwi fruits (*Actinidia deliciosa*) used in this study was purchased from a local market. (DPPH˙) 2, 2-diphenyl-1-picrylhydrazyl- hydrate were purchased from Sigma Chemical Co. (St. Louis, Mo, USA), and Folin–Ciocalteu reagent, quercetin , tannic acid and gallic acid were obtained from Merck Co. (Darmstadt, Germany). All the reagents were of analytical grade.

Methods

Development and standardization of milk

Soybean was prepared according to the procedure described by Bisla (2012). The preparation process involved the cleaning and dehulling of seeds. For the preparation of milk (100gm) seeds were soaked in water containing 1% sodium hydroxide overnight at room temperature in the ratio of 1:4 (w/v). After soaking husks were removed by rubbing with hands. Then soaked seeds were blanched for 15 minutes in boiling water. Seeds were taken out and the remaining water was drained out. After that 400ml of water was added to seeds and blended in a grinder. The resulting suspension was then filtered through a double layer muslin cloth.

Fruits preparations

Kiwi and papaya fruits were handpicked thoroughly to ensure uniformity in size, maturity, color, and other sensory parameters. The fruits were hand-peeled with a stainless steel knife and then cut into slices with 5 mm thickness and a diameter of approximately 50 mm (Qadri *et al*., 2020). Then, all fruits were put in citric acid 0.5% for one minute (Zaghloul *et al*., 2012). The solar dryer was used for drying at (40-47 ± 2ºC), air velocity was kept constant at 1.9-2.4m/s and relative humidity of drying was ranged from (2-5%). The dried fruits were milled and packed in polyethylene bags until used.

Procedure for manufacturing ice soy milk:

Ice soymilk, flavoring materials (2% vanilla), 0.07% stabilizer (gelatin), 19.8% sugar, 0.79% corn syrup solids was prepared. The mix was pasteurized at 72°C for 15 s (Stork Friesland). The required amounts of fruit (kiwi, papaya) were added throwing frozen in an ice milk machine after cooling to 4°C and then aged overnight at 4°C frozene at percentage of 5%, 10% and 15% for fresh kiwi (FK 5%, FK 10%, and FK 15%), fresh papaya (FP 5%, FP 10%, FP 15%), while percentage of kiwi and papaya powder were (KP 0.5%, KP 1%, KP 1.5%) and (PP 0.5%, PP 1%, PP 1.5%), respectively. The resultant ice milk was packaged in cups (100 cc) and kept in a freezing cabinet at –18°C for 24 hours at least before evaluation (Bikheet *et al*., 2018).

Physiochemical parameters

Quality attributes

The total solids and ash content of ice soymilks were determined according to AOAC (2002). Non-enzymatic browning (NEB) was evaluated at 420 nm (Ranganna, 1986). The Overrun was calculated by volume (Arbuckle 1986) as follow:

$$\% \text{ Overrun} = \frac{\text{Volume of ice soymilk} - \text{Volume of mix}}{\text{Volume of mix}} \times 100$$

Determination of color

Color characteristics were measured by a color difference meter (model color Tec-PCM, USA) according to the method described by Francis 1983. The numerical total color difference (ΔE), hue angle and color intensity (chroma) were calculated using the following equations:

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

$$\text{Hue angle} = [\tan^{-1} (b/a)]$$

$$\text{Chroma} = [(a^2+b^2)]^{1/2}.$$

ΔL ($L–L_0$), Δa ($a–a_0$) and Δb ($b–b_0$), whereas L_0, a_0 and b_0 were the L, a, and b values of the reference sample which is the control one.

Determinations of pigments

Chlorophylls and carotenoids were determined according to the modification of the spectro-colorimetric procedure given by Owayss *et al*., (2004). Pigments were expressed as μg/100g weight of ice soy milks according to the following equations:

$$\text{Chlorophyll } a = 12.7 \times OD_{663} – 2.69 \times OD_{645}$$

$$\text{Chlorophyll } b = 22.4 \times OD_{645} – 4.68 \times OD_{663}$$

$$\text{Total chlorophylls} = 8.02 \times OD_{663} + 20.2 \times OD_{645}$$

$$\text{Carotenoids} = OD_{480} + (0.114 \times OD_{663} – 0.638 \times OD_{645}).$$

Phytochemical parameters

Determination of Total Phenolic Contents

The amount of phenolic compounds in ice soy milk extracts were determined by the Folin–Ciocalteu colorimetric method (Lim *et al*., 2007). The total phenolic content was expressed as mg gallic acid equivalent (GAE) at 735 nm.

Determination of Total Flavonoids

Total flavonoids content were determined by using the method of Kumaran and Karunakaran (2007).The total flavonoids was calculated by the following equation:

$$X = (A \times m_0)/ (A_0 \times m)$$

Whereas, **X is the flavonoids content (mg/mg extract in quercetin equivalents(QE), A is the absorption at 415 nm of extract solution, A_0 is the absorption of standard quercetin solution, m is the weight of ice soymilk (mg) in extract and m_0 is the weight of quercetin in the solution (mg).**

Determination of Total Tannins

Total tannins content was determined using the colorimetric method described by Linskens and Jackson (1995). Tannins content was calculated and expressed as mg tannic acid/100g.

Determination of antioxidant activity by DPPH

The antioxidant activity of extracts was determined by the method described by Lim *et al*. (2007). Inhibition of DPPH free radical at 517 nm in percent was calculated from the following equation:

$$\text{Inhibition\%} = [(A_{\text{control}} – A_{\text{sample}})/ A_{\text{control}}] \times 100$$

Microbiological analysis

Counts of bacteria were determined using NA (nutrient agar), fungi were determined using PDA (potatoes dextrose agar) and E. coli was detected using Macconocky agar (APHA, 1994).

Sensory analysis

Sensorial properties of the ice soy milk samples were tested by 15 trained panelists using a sensorial rating scale color, flavor, taste, mouth feel, texture and experience of ice soymilk samples were evaluated by sensory analysis (Atallah *et al*., 2017).

Statically analysis

Experimental results were means of three parallel measurements. Analysis of variance was performed by ANOVA procedures. SPSS 19.0 was for statistical calculations Graph Pad Software, San Diego, CA, USA.

RESULTS AND DISCUSSION

Incorporation of fresh papaya and kiwi or dried forms, which used in ice soy milk preparations significantly (*p<0.05)* affected in total solids, ash, antioxidant activity, phenols, tannins, flavonoids, pigments and overrun. Total solids play an important role in controlling ice soy milk quality. The total solids content (Table1), increased as the level of dried fruits was raised due to their high dry matter content. Similar results were earlier reported by Goraya *et al*. (2015).

The ash content of all ice soy milk samples increased with the augmentation of dried fruits in comparison with control. The results obtained in this study were a good agreement with what obtained by Atallah 2017, who found that the addition of fruits pulp, paste, and juices increased the ash content in ice products.

Comparing ice soy milks, it seems that the overrun significantly (*p<0.05)* differed among treatments (Table 1). As to be noted, that the amount and type of non-dairy solids used to replace nonfat milk solids in ice milk mixes negatively affected the overrun. Control ice soy milk had a higher overrun which was reduced by the addition of fruits, while the lowest overrun was ranged from (55% to 61%) when dried fruits were used. So, findings were observed by Shrestha and Maskey (2018), who also found that the overrun was positively affected by higher concentrations of soy milk.

Table 1. Quality attributes and color properties of supplemental ice soy milk with papaya or kiwi fruits.

Samples	Moisture(%)	TSS(%)	Ash (%)	Overrun(%)	L	A	B	Chroma	ΔE
Control	71.84^{a}±0.08	28.16^{d}±0.08	0.39^{a}±0.001	70.47^{a}±0.46	91.50^{a}±1.44	-7.41^{abc}±0.39	6.80^{c}±0.10	7.72^{e}±0.04	0
FP 5%	71.24^{b}±0.43	28.76^{c}±0.43	0.32^{d}±0.030	64.33^{b}±0.60	85.02^{c}±0.45	1.65^{ab}±0.53	12.49^{b}±1.14	12.61^{c}±1.17	10.0^{d}±1.00
FP 10%	70.95^{bc}±0.11	29.05^{bc}±0.11	0.32^{c}±0.006	62.93^{c}±0.81	79.97^{d}±0.36	3.33^{a}±0.12	13.57^{b}±1.48	13.97^{c}±1.45	15.0^{c}±1.00
FP 15%	70.48^{c}±0.44	29.52^{b}±0.44	0.33^{b}±0.006	60.33^{d}±0.60	72.95^{e}±1.90	5.57^{a}±1.24	24.60^{a}±2.84	24.33^{a}±1.69	27.33^{a}±2.52
FK 5%	70.58^{c}±0.04	29.42^{b}±0.04	0.22^{c}±0.001	64.93^{b}±0.40	88.38^{b}±0.58	-7.27^{bc}±1.07	7.20^{c}±0.25	8.96^{de}±0.40	3.67^{f}±0.58
FK 10%	70.47^{c}±0.20	29.53^{b}±0.20	0.34^{c}±0.004	62.60^{c}±0.40	85.31^{c}±0.56	-10.04^{bc}±0.97	8.98^{c}±0.29	13.43^{cd}±0.48	7.33^{e}±0.58
FK 15%	69.86^{d}±0.14	30.14^{a}±0.14	0.37^{c}±0.003	60.80^{d}±0.52	80.96^{d}±1.53	-15.68^{c}±2.84	13.66^{b}±2.29	19.78^{b}±2.48	17.67^{b}±1.53
LSD	0.44	0.44	0.02	0.95	2.02	8.72	2.72	2.71	2.62
Control	71.84^{a}±0.08	28.16^{e}±0.08	0.39^{g}±0.001	70.47^{a}±0.46	91.50^{a}±1.44	-7.41^{d}±0.39	6.80^{d}±0.10	7.72^{e}±0.04	0
PP 0.5%	69.25^{bc}±0.13	30.75^{cd}±0.13	0.55^{e}±0.006	61.40^{cd}±1.20	90.69^{a}±0.90	1.16^{c}±2.63	9.68^{c}±1.45	9.97^{d}±1.52	6.67^{c}±1.15
PP 1.0%	68.51^{d}±0.51	31.49^{b}±0.51	0.65^{c}±0.006	59.67^{bc}±0.56	89.10^{bc}±1.08	4.24^{b}±0.82	11.25^{b}±1.13	12.04^{c}±1.16	9.33^{b}±0.58
PP 1.5%	67.62^{e}±0.05	32.38^{a}±0.05	0.83^{a}±0.006	55.53^{d}±0.40	83.26^{e}±0.54	5.82^{a}±0.66	14.82^{a}±1.33	15.94^{a}±1.18	15.0^{a}±1.00
KP 0.5%	69.39^{b}±0.04	30.61^{d}±0.04	0.64^{f}±0.003	60.03^{b}±0.06	90.54^{ab}±2.17	-6.83^{d}±1.11	6.66^{d}±0.66	7.90^{e}±0.31	2.0^{d}±1.73
KP 1.0%	69.10^{bc}±0.47	30.90^{cd}±0.47	0.70^{d}±0.006	60.33^{cd}±0.60	87.44^{cd}±1.19	-7.12^{e}±0.71	8.03^{d}±0.38	10.74^{d}±0.53	5.67^{c}±0.58
KP 1.5%	68.82^{cd}±0.06	31.18^{bc}±0.06	0.90^{b}±0.006	59.17^{e}±0.30	85.06^{de}±1.43	-8.16^{e}±1.03	10.97^{bc}±0.32	13.69^{b}±0.42	8.67^{b}±1.15
LSD	0.47	0.47	0.008	1.06	2.34	1.43	1.6	1.56	1.81

Values are expressed as mean± standard deviation (*N*=3). Values with the same letter in the same column are not statistically different (p<0.05). FP 5% (fresh papaya 5%), FP 10 %(fresh papaya 10%), FP 15% (fresh papaya 15%), PP 0.5%(papaya powder 0.5%), PP 1%(papaya powder 1%), PP 1.5% (papaya powder 1.5%), FK 5% (fresh kiwi 5%), FK 10 %(fresh kiwi 10%), FK 15% (fresh kiwi 15%), KP 0.5%(kiwi powder 0.5%), KP 1%(kiwi powder 1%), KP 1.5%(kiwi powder 1.5%).

Color attributes and NEB

*L** value which designates whiteness of the product, decreased significantly *(p<0.05*) as the level of kiwi or papaya incorporation increased (Table 1). Goraya and Bajwa (2015), reported that the *L** value decreased, which reflected the addition of product and their oxidation that made product darker and in turn increased the absorption of light.

The greenness of ice soy milks were increased as the level of kiwi increased, which reflected the negative *a** value. Ice soy milk with fresh kiwi was showed greener color than powder, whereas ice soy milks with papaya had more red color when compared to the control. This may be related to β- carotene (Chakraborty *et al*., 2019*)*. An increase in levels of fresh papaya increased the *b** values of ice soy milk; however, it increased less by the addition of papaya powder. Goraya *et al.* (2015) reported that the addition of phenolic substances caused a significant change in the color properties of ice milk products compared to control.

The ΔE values, which are indicators of total color difference, showed that there were significant differences (*p<0.05)* in color between ice soy milks, fresh fruits as well as powder fruits (Table 1). In general, the ΔE was a significantly high difference in FP 15% and FK 15% compared to control. These results demonstrate that the color stability of ice soy milks depends on the percentage of added fruits.

Figure (1a) shows that there was a gradual increase in the NBE from 0.05 to 0.071 after drying. The results of the color variation of ice soy milks were correlated with the NBE obtained during the time of monitoring. Other studies have shown that the NBE is correlated to antioxidant activity (Nooshkam *et al*., 2019). Moreover, higher browning was found with a higher concentration of gallic acid. Various authors estimated that the decrease in the value of *L** was associated with an increase in the darkening of food (Concha-Meyer *et al*., 2016).

Phytochemical Attributes:

Total phenols, total flavonoids, tannins and total pigments including chlorophylls and carotenoids were quantified and tabulated in Table 2. Total phenol increased significantly by the addition of fresh papaya (FP), this increment ranged between (16 to ~35%), followed by fresh kiwi (FK) (8 to ~20%), papaya powder (PP) from 7 to 17%, and finally, kiwi powder (KP) (3.4 to 11.3%)

compared to control. Furthermore, these products show a good source of flavonoids (Table 2). Incorporation of FP 15% and FK 15% enhanced significantly ($p<0.05$) release of flavonoids by more than 40% and 69% compared to control, respectively. This variation mainly resulted from the fruit's variation (Cai *et al*., 2019). Furthermore, dried fruits increased significantly TF contents compared to the control sample. Data obtained here indicated that flavonoids were the most abundant bioactive agent and may provide daily adult needs. Nevertheless, flavonoid intakes are reported to range from around 21.2 mg/day to 191.2 mg/day in elderly adults (Chun 2012).

Table 2. Phytochemical and antioxidant activity of supplemental ice soy milk with papaya or kiwi fruits.

Samples	TP (mg GAE/100g)	TF (mg QE/100g)	Tannins (mg TA/100g)	DPPH
Control	453.72^{f}±.30	383.91^{e}±10.10	307.6^{e}±6.16	82.01^{d}±1.3
FP 5%	526.76^{cd}±1.18	481.55^{d}±2.35	374.44^{d}±10.4	92.99^{c}±0.2
FP 10%	576.93^{b}±3.02	508.13^{d}±3.13	460.05^{d}±7.46	94.85^{abc}±1.8
FP 15%	612.37^{a}±0.57	538.66^{c}±2.29	494.11^{c}±5.02	95.45^{ab}±1.6
FK 5%	491.5^{e}±12.7	579.29^{b}±2.25	366.73^{b}±3.89	93.33^{bc}±0.5
FK 10%	513.9^{d}±25.7	621.75^{a}±21.6	393.09^{a}±12.3	95.32^{ab}±1.0
FK 15%	544.7^{c}±4.32	649.48^{a}±16.9	418.58^{a}±5.09	96.03^{a}±0.8
LSD	19.69	28.47	33.46	2.03
Control	453.72^{e}±0.30	383.91^{g}±10.1	307.6^{d}±6.16	82.01^{c}±1.3
PP 0.5%	485.58^{c}±7.39	408.68^{f}±9.08	326.25^{cd}±8.20	93.33^{ab}±1.1
PP 1.0%	506.71^{b}±1.66	436.32^{e}±2.21	345.41^{bc}±1.43	94.11^{ab}±2.0
PP 1.5%	530.94^{a}±3.78	484.1^{d}±12.96	358.97^{abc}±0.83	95.76^{a}±0.7
KP 0.5%	469.55^{d}±2.80	499.22^{c}±2.23	336.16^{bcd}±5.68	92.93^{b}±1.3
KP 1.0%	486.12^{c}±6.32	520.68^{b}±4.41	365.65^{ab}±0.29	93.94^{ab}±0.7
KP 1.5%	504.94^{b}±4.00	555.94^{a}±8.42	385.08^{a}±8.27	94.88^{ab}±1.4
LSD	8.44	14.08	32.05	2.24

Values are expressed as mean± standard deviation (*N*=3). Values with the same letter in the same column are not statistically different ($p<0.05$). FP 5% (fresh papaya 5%), FP 10 %(fresh papaya 10%), FP 15% (fresh papaya 15%), PP 0.5%(papaya powder 0.5%), PP 1%(papaya powder 1%), PP 1.5%(papaya powder 1.5%), FK 5% (fresh kiwi 5%), FK 10 %(fresh kiwi 10%), FK 15% (fresh kiwi 15%), KP 0.5%(kiwi powder 0.5%), KP 1%(kiwi powder 1%), KP 1.5%(kiwi powder 1.5%).Total phenols (TP) are expressed in mg of gallic acid per 100 g , total flavonoids (TF) content is expressed in mg of quercetin per 100 g. Tannins are expressed in mg tannic acid per 100g.

Tannin's contents of FP or FK were higher than the PP and KP. All ice soy milks were significantly ($p<0.05$) higher than control. Tannin content was increased by using fresh kiwi or papaya about 36% and 60% compared to control%, respectively. The highest tannin was found in FP 15% with 491.4 mg/100g, while the lowest value was 326.2 mg/100g in PP 0.5% with no significant difference between FK 10% and FK 15% as well as FP 5% and FP 10%. The pretreatment of soy seed before milk extraction helped to reduce the level of tannins which give the ice soy milk an astringent taste (Mehanni *et al*., 2017).

Carotenoid content was different significantly ($p < 0.05$) in fresh ice soy milk from those of dried ones (Figure 1a). Ice soy milk with FP 15% contained double-fold carotenoids more than PP 1.5%, three-folds more of FK 15% and finally, about five-folds more than the control.

Chlorophyll is another pigment closely associated with the fruits (Figure 1b). Kiwi fruit, contained between (2.6 and 4.2 mg/100 g FW), has up to 3.2 times the chlorophyll concentration of papaya fruits. Ice soy milk with 15% FK increased chlorophyll content by 5.5 times comparing to FP 15%. Chlorophyll a is the predominant form in both kiwi and papaya fruit (Drummond *et al*., 2013). Mak *et al*., (2013), reported that carotenoids and chlorophyll may be responsible for antioxidant effects.

Using citric acid with fresh fruits before drying was a very useful step to reduce the percentage loss of bioactive components (Zaghloul *et al*., 2012). A reduction in flavonoids was only about 16% in both fruits, whereas the tannins decreased by 8.34 % and 27.3 % in kiwi and papaya, respectively. The decrease in the total content of phenolic compounds showed a similar pattern to the minimum decrease in average total flavonoid compound content (Wang *et al*., 2018 and Akar *et al*., 2019).

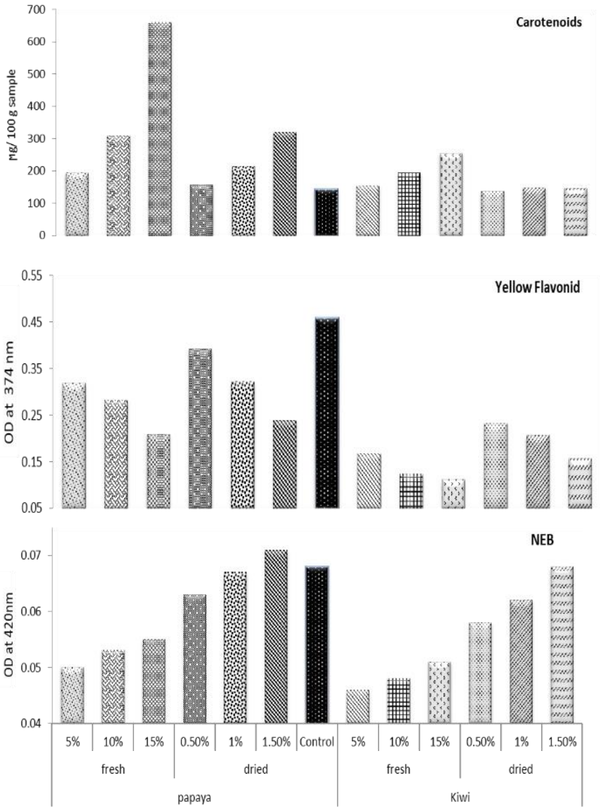

Figure 1a. Pigment contents in ice soy milk with fresh and dry fruits

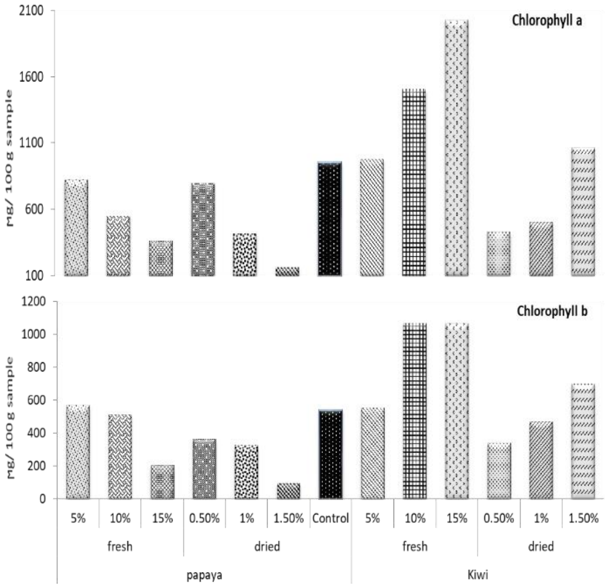

Figure 1b. Pigment contents in ice soy milk with fresh and dry fruits.

DPPH Scavenging Activity

The free radical scavenging activity of ice soy milk extracts (Table 2) increased by increasing the percentage of fruits through the donation of proton forming the reduced DPPH (Scepankova *et al*., 2018). The highest scavenging activity was recorded by FK 15% as (96.0%), followed by FK 10% (95.3%) and finally (93.3%) at a concentration of FK 5%, While in fresh papaya ice soy milk extracts, the scavenging activity ranked as follows: 15% FP (95.4%) > 10%FP (94.8%) > 5% FP (93.3%) providing that the antioxidant activity depends on the component.

The same trend was found in ice soy milk extracts with dried fruits with no significant difference between the KP extract. All individual extracts inhibition was found to be significantly high ($p<0.05$) difference compared with control. Thus, the maximum inhibition occurred using 15% FK and FP 15%. This indicates that the maximum free radical scavenging potential of ice soymilk extracts due to their hydrogen donating ability. The results obtained in this study are in good agreement with what was found by Pillai and Mini (2014), who stated that strong free radical scavenging activity exhibited by extracts, could be attributed to high phenols, flavonoids as well as pigments and chlorophylls.

Microbiological Qualities:

Microbiological qualities of ice soy milk with kiwi and papaya are presented in Table (3). Results obtained show that ice soy milk either the control or the fortified samples had no yeast, molds nor E. Coli and the total bacterial count were in the range between $1.2*10^2$ -$7*10^2$ CFU/g. The total bacterial count of the ice soy milk formulations was within the safe levels. The total bacterial count for an ice soy milk product must not be over $15*10^4$ CFU/g. according to the Egyptian organization for standardization and Quality (2005).

Organoleptic Properties:

Sensory scores of ice soy milk samples are shown in Figure (2). The scoring of flavor, appearance & color and the overall fresh fruit liking scores were increased significantly. This indicates that there was no negative effect on the overall acceptability of ice fresh soy milk. Ice soy milk with papaya was characterized by a yellow color because of carotene content. This color was accepted by the panelists, whereas kiwi ice soy milk has a favorites taste. No significant ($p>0.05$) differences were found in scores for color and acceptability between different powder treatments as well as control. In this study, the highest score was found to be when using FP 10% and FK 15% as overall acceptability.

Table 3. Microbiological qualities of ice soy milk with kiwi or papaya.

Samples	Bacteria	Yeast	Molds	E.coli
Control	1.0×10^{2}	N.D	N.D	N.D
FK 5%	10×10^{2}	N.D	N.D	N.D
FK 10%	7.0×10^{2}	N.D	N.D	N.D
FK 15%	5.3×10^{2}	N.D	N.D	N.D
FP 5%	6.0×10^{2}	N.D	N.D	N.D
FP 10%	2.4×10^{2}	N.D	N.D	N.D
FP 15%	2.8×10^{2}	N.D	N.D	N.D
Control	1.0×10^{2}	N.D	N.D	N.D
PK 0.5%	1.3×10^{2}	N.D	N.D	N.D
PK 1.0%	3×10^{1}	N.D	N.D	N.D
PK 1.5%	2×10^{1}	N.D	N.D	N.D
PP 0.5%	3×10^{1}	N.D	N.D	N.D
PP 1.0%	2×10^{1}	N.D	N.D	N.D
PP 1.5%	2×10^{1}	N.D	N.D	N.D

Values are expressed as (CFU/g), mean (*N*=3) FP 5% (fresh papaya 5%), FP 10 %(fresh papaya 10%), FP 15% (fresh papaya 15%), PP 0.5% (papaya powder 0.5%), PP 1%(papaya powder 1%), PP 1.5% (papaya powder 1.5%), FK 5% (fresh kiwi 5%), FK 10%(fresh kiwi 10%), FK 15% (fresh kiwi 15%), PK 0.5%(kiwi powder 0.5%), PK 1%(kiwi powder 1%), PK 1.5%(kiwi powder 1.5%). N.D: not detected

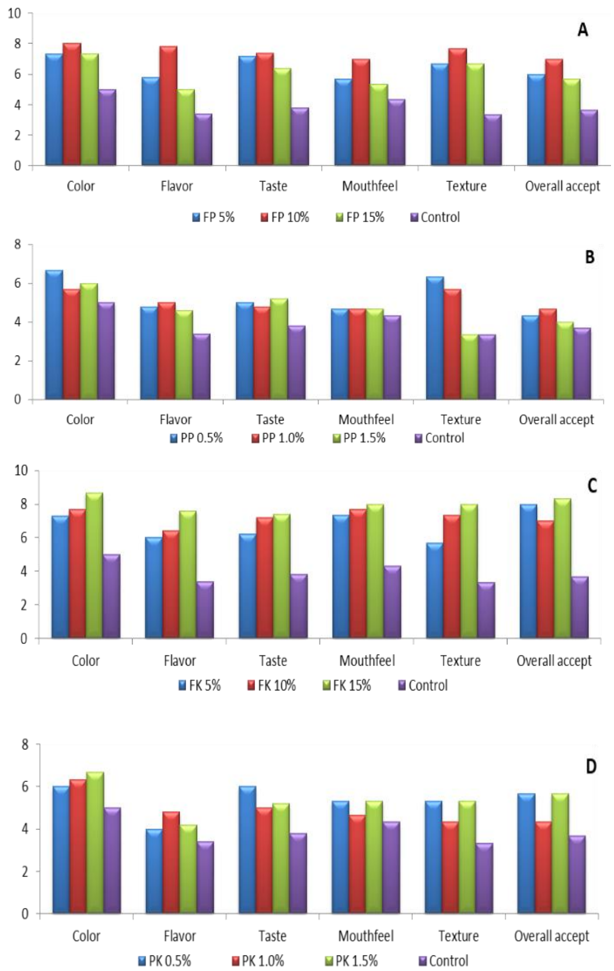

Figure 2. Sensory evaluations of ice soy milk with fresh and dry fruits, A: fresh papaya, B: dry papaya, C: fresh kiwi and D: dry kiwi.

Correlations

Correlations showed in (Table 4 & 5) between physicochemical, phytochemical and radical scavenging activity (RSA) in ice soy milk with fresh fruits or dry fruits.

TF and TP showed in (Table 4 & 5), a positive significant correlation with DPPH radical-scavenging activity as (*r =0.777 and r =0.709, P <* 0.01), respectively. Except for NEB and yellow flavonoid, which showed a negative correlation in fresh extract *(r= -0.823* and *r = -0.829, P<* 0.01), respectively. From the results obtained in table 4, dried extracts had lower total flavonoid correlations with DPPH (*r =0.634, P <* 0.01) compared with fresh extracts. This suggests the presence of compounds in the extracts with relatively weak radical-scavenging activity but maybe have a good metal-chelating ability that can prevent the generation of hydroxyl radicals (Scepankova *et al*., 2018).

The tannin content of both fresh and dry extract also has a significantly positive correlation to its antioxidant activity (*r = 0.727* and *r =*0*.670, P <* 0.01), respectively. Tannins do not act as pro-oxidants and in fact, react very rapidly to quench the hydroxyl radical. The tannins in the fresh extract may contain both hydrolysable and condensed tannins since both have got a wide array of antioxidant mechanisms like free radical scavenging activity, chelation of transition metals, inhibition of pro-oxidative enzymes and lipid peroxidation (Gülçin *et al*., 2010). Hence the high content of tannin in fresh extract explains very well its antioxidant action.

A strong negative correlation was found between TSS and overrun (*r = -0.807* and *r = -0.843, P <* 0.01) in fresh and dry supplemented ice soy milk, respectively. Findings of Shrestha and Maskey (2018) were also parallel with these results as the overrun of soy ice cream was positively affected by higher concentrations of soy milk due to interaction effect which can be attributed to increased total solids content in ice soy milk.

Table 4. Correlation coefficients between physiochemical, phytochemical and radical scavenging activity (RSA) in ice soy milk with fresh fruits

Correlations	Physiochemical						Phytochemical							RSA
	Overun	NEB	L	A	B	Chroma	TP	TF	Tannins	Carotenoids	YF	Chlo. a	Chlo.b	DPPH
TSS	-.807**	-.636**	-.486*	-.230	.290	.498*	.446*	.888**	.502*	.300	-.901**	.479*	.421	.788**
NEB		1	.208	.138	-.018	-.086	-.277	-.771**	-.318	.042	.805**	-.235	-.332	-.823**
L			1	-.351	-.920**	-.931**	-.952**	-.344	-.916**	-.900**	.390	.276	.285	-.641**
A				1	.559**	.200	.450*	-.419	.398	.510*	.322	-.738**	-.680**	.078
B					1	.916**	.871**	.121	.818**	.943**	-.184	-.400	-.461*	.451*
Chroma						1	.836**	.351	.799**	.871**	-.376	-.101	-.208	.516*
TP							1	.302	.930**	.848**	-.368	-.339	-.309	.709**
TF								1	.415	.102	-.978**	.594**	.596**	.777**
Tannins									1	.816**	-.455*	-.285	-.245	.727**
Carotenoids										1	-.184	-.486*	-.546*	.399
YF											1	-.497*	-.502*	-.829**
Chlo. a												1	.937**	.139
Chlo. b													1	.217
DPPH														1

***Correlation is significant at the 0.05 level (2-tailed) according to Pearson, ** Correlation is significant at the 0.01 level (2-tailed) according to Pearson. Chlo. a: Chlorophyll a, Chlo. b: Chlorophyll b and Y.F: Yellow Flavonoids**

Table 5. Correlation coefficients between physiochemical, phytochemical and radical scavenging activity (RSA) in ice soy milk with dry fruits.

Correlations	Physiochemical						Phytochemical							RSA
	Overun	NEB	L	A	B	Chroma	TP	TF	Tannins	Carotenoids	YF	Chlo. a	Chlo.b	DPPH
TSS	-.843**													
NEB	0.024	1												
L	.548*	-.514*	1											
A	0.002	0.33	0.005	1										
B	-.522*	.700**	-.643**	.587**	1									
Chroma	-.590**	.717**	-.785**	0.339	.945**	1								
TP	-.707**	.542*	-.741**	.481*	.929**	.932**	1							
TF	-.737**	-0.129	-.664**	-.483*	0.182	0.401	0.41	1						
Tannins	-.716**	0.156	-.639**	-0.226	0.407	.579**	.605**	.800**	1					
Carotenoids	-0.216	.637**	-.572**	.764**	.844**	.754**	.793**	-0.016	0.174	1				
YF	.795**	0.111	.700**	0.34	-0.27	-.459*	-.509*	-.979**	-.776**	-0.114	1			
Chlo. a	0.177	0.061	0.306	-.604**	-0.372	-0.279	-.470*	-0.099	-0.085	-.687**	0.248	1		
Chlo. b	0.039	-0.077	0.13	-.850**	-.464*	-0.273	-.445*	0.222	0.147	-.781**	-0.071	.887**	1	
DPPH	-.904**	-0.08	-.475*	0.232	.560**	.576**	.748**	.634**	.670**	0.382	-.723**	-.461*	-0.328	1

*** Correlation is significant at the 0.05 level (2-tailed) according to Pearson, ** Correlation is significant at the 0.01 level (2-tailed) according to Pearson. . Chlo. a: Chlorophyll a, Chlo. b: Chlorophyll b and Y.F: Yellow Flavonoids**

The 'b' value was increment with increased percentage of fresh fruits and had a significant strong correlation with carotenoids (*r =0.943, P<* 0.01), TP (*r =0.871, P<* 0.01) and tannins (*r =0.818, P<* 0.01) but not with tannins in ice soy milk with dried fruits. NEB had a significant strong correlation with yellow flavonoid (*r= 0.805, P<* 0.01) and negative significant correlation with TF (*r = -0.771, P<* 0.01) and DPPH (*r = -0.823, P<* 0.01), in fresh fruits supplemented ice soy milks, while it had a significant correlation (*r =0.542, P<* 0.05, and *r = 0.637, P<* 0.01) with TP and carotenoids in dried fruits supplemented with ice soy milk, respectively.

CONCLUSION

The nondairy industry has great potential, especially due to the complications that the dairy industry faces such as lactose intolerance. However, conclusive research experiments should be conducted for management and improvement of various health-related issues as well as the role of different foods in developing new economically and nutritionally equivalent products for cow's milk, besides meeting consumer acceptability. Thus, ice soy milks with 10% fresh papaya or 15% kiwi can therefore be recommended and considered as functional foods with high-quality attribute and acceptance.

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الخصائص الوظيفية ودرجه التقبل لمثلج لبن فول الصويا المدعم بالكيوى او الباباظ

رقيه رمضان عبدالسلام [1]، مها محمود بخيت[2] و احمد شوقى زهران[2]

[1]قسم علوم الاغذيه- كليه الزراعه- جامعه المنيا

[2]قسم الالبان- كليه الزراعه- جامعه المنيا

ان الحصول على منتجات لبنيه خاليه من سكر اللاكتوز يؤدى الى حل مشكله من يعانون من عدم تحمل سكر اللاكتوز ، اما من يعانون من الحساسيه الغذائيه فما زالت المشكله باقيه. يعتبر لبن فول الصويا مصدر غير جيد لمضادات الأكسدة لذلك فان هذا البحث تم اجراؤه بهدف زياده الصفات الوظيفية للبن فول الصويا وذلك عن طريق تدعيمه بالكيوى او البباظ سواء على على الصوره الطازجة او المجففة. تم تحضير لبن فول الصويا المجمد باستخدام نسب مختلفه من الكيوى او البباظ الطازج (5٪،10٪،15٪) و بنسب (.5٪،1٪،1.5٪) للكيوى والبباظ .فلقد أدت عمليه تدعيم مثلج لبن فول الصويا بالبباظ او الكيوى سواء فى صوره طازجه او مجففه الى زياده المحتوى من الفلافونيدات بنسبه 40٪ فى حاله اضافه البباظ الطازج و 60٪ فى حاله اضافه الكيوى الطازج. كما أدت هذه الاضافه الى زياده الفينولات الكليه بنسبه 20٪،35٪ والتانينات بنسبه 36٪،60٪ وذلك عند اضافه الكيوى الطازج والبباظ على الترتيب عند مقارنتهم بالكنترول. ادى معامله الفاكهه الطازجة قبل تجفيفها بحامض الستريك الى تقليل الفقد فى الفينولات الى 13٪ والفلافونيدات الى 16٪ والتانينات بنسبه قد تصل الى 27٪ . وجدت الكاروتيندات فى اعلى قيمه لها فى بباظ طازج15 ٪ مقارنه بالمثلج المدعم ب 1.5٪ بباظ مجفف و الكيوى الطازج15 ٪..انخفضت نسبه الريع الكلى نتيجه استخدام اى من الكيوى او البباظ المجفف. لبن الصويا المجمد والمدعم بالكيوى او البباظ آمن من الناحيه الميكروبية. لوحظ وجود علاقه ايجابيه معنوية بين المكونات الحيوية النشطه و DPPH سواء كانت الفينولات الكليه (*r =0.638*) و التانينات (*r =0.673*) و المركبات الفلافونيديه (*r =0.727*).و وكذلك كان لها ارتباط سلبي مع كما توجد علاقه معنوية سالبه و NEB (*r = -0.823*) و والفلافونويد الأصفر (*r = -0.829*) . زادت قيمه b مع زياده نسبه الفاكهه الطازجة المضافة لعلاقتها بالكاروتينات (*r =0.943*) و التانينات (*r =0.818*) و الفينولات(r =*0.871*) . ان مثلج فول الصويا والمنتج عن طريق أضافه 15٪ كيوى طازج او 10٪ بباظ طازج يمكن استخدامه كمنتج وظيفى مقبول لدى الذين يعانون من أعراض عدم تحمل سكر اللاكتوز والحساسيه الغذائيه.