# Maejo International Journal of Science and Technology

ISSN 1905-7873 Available online at www.mijst.mju.ac.th

Full Paper

# Development of Job's tears ice cream recipes with carrot juice and pumpkin paste

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Received: 17 January 2011 / Accepted: 6 November 2011 / Published: 25 November 2011

Abstract: Carrot juice and pumpkin paste were used as ingredients in Job's tears ice cream. Carrot juice or pumpkin paste added at 50% was equally preferred by 100 consumers compared to the original Job's tears ice cream. The new types of ice cream were lower in antioxidant capacity and higher in total phenolic content but could still be considered as potential antioxidant products. Purchase intent was significantly increased ( $p \le 0.05$ ) if consumers were informed about the nutritional and antioxidant capacity of these products.

Key words: Job's tears, Job's tears ice cream, antioxidant capacity, purchase intent

# INTRODUCTION

Job's tears or adlay (*Coix lacryma-jobi* L.) is a grass native to tropical Asia [1]. It is classified into 4 varieties: *lacryma-jobi*, *stenocarpa* Stapf, *monilifer* Watt, and *ma-yuen* (Rom.) Stapf [2]. Job's tears has been used in traditional Chinese and Indian medicine [3-5]. Kanglaite, a neutral lipid extract from the endosperm of Job's tears, has been endorsed as a treatment for lung, liver, stomach and breast cancers by the Chinese government [6]. Medicinally beneficial compounds in Job's tears seeds have been discovered. For example, coixenolide [7], palmitic acid, stearic acid, oleic acid and linoleic acid [8] have antitumour activity. Benzoxazinones show anti-inflammatory activity [9] and coixan A, B and C possess hypoglycemic activity [10]. Six phenolic compounds, viz. coniferyl alcohol, syringic acid, ferulic acid, syringaresinol, 4-ketopinoresinol and mayuenolide, have strong antioxidant effects [11]. Owing to its beneficial components, Job's tears is considered a functional food ingredient.

Job's tears (*Coix lacryma-jobi* L var. *ma-yuen* (Rom.) Stapf) is grown in Thailand [2]. The hulled grains are edible in the same way as cereal foods and can be ground into flour [12]. Unfortunately, Thai people rarely consume Job's tears. There are only one conventional dessert made from Job's tears mixed with sugar and coconut milk, and a few of non-dairy drinks with Job's tears, alone or mixed with other cereals, available in the market. More Job's tears products should be introduced to Thai consumers for consumption.

Ice cream, a favourite dessert for everyone, is a frozen combination of milk, sweeteners, stabilisers, emulsifiers and flavourings. This mixture is pasteurised and homogenised before rapid freezing with agitation to incorporate air to make a smooth and soft frozen product [13]. In Thailand, a Thai-style ice cream called "i-tim ga ti" is made from coconut milk. Its taste is different from a milk-based ice cream whilst its texture is between milk ice cream and sorbet. Thais and foreigners relish its unique flavour and texture [14-15]. A trial using Job's tears together with coconut milk for making ice cream was done and 64 of 100 Thai participants preferred Job's tears-based ice cream [16]. A recipe of Job's tears-based ice cream was developed [17].

To promote consumption of the healthful Job's tears by introducing its new acceptable and easy-to-eat products, this study aims to make new Job's tears-based ice cream recipes by adding carrot juice or pumpkin paste. This should make for more colourful and flavoured products with more health benefits to consumers due to the phenolic compounds present in carrot [18] and pumpkin [19]. The effect of awareness of the nutritional and antioxidant capacities of the ingredients on the intention to buy Job's tears-based ice cream was also studied.

#### MATERIALS AND METHODS

#### **Ice Cream Mix Preparation**

Job's tears seeds (Rai Tip brand) were washed, soaked in water for 2 hours, boiled for 40 minutes, and blended with water in a weight ratio of 1:2 (boiled seeds:water) by means of a blender. Water was added to adjust the total solids of blended Job's tears to 8% (w/w). Coconut milk (Chaokoh brand), glucose syrup (5 Star Elephant brand), sucrose (Mitr Phol brand) and salt (Prung Thip brand) at 50, 32, 20 and 0.4% respectively of the 8% Job's tears blend were added to the mixture to make the Job's tears ice cream mix [17], which was blended, heated at 80°C for 15 minutes, cooled rapidly and stored overnight in a refrigerator before being made into ice cream by means of an ice cream maker (JCS Technic Line Co., Ltd.).

Carrot juice, prepared from fresh orange carrot (bought from a local market) by a fruit juice extractor, was added to the Job's tears ice cream mix above at 0, 25, 50, 75 and 100% (w/w) of the 8% Job's tears blend. The mixture was blended, pasteurised, stored in the refrigerator overnight and ice cream was made.

Pumpkin paste, prepared by steaming fresh pumpkin (bought from a local market) for 25 minutes and blending the steamed pumpkin flesh with water in a ratio of 1:1 (steamed pumpkin flesh:water) by means of a blender, was added to the Job's tears ice cream mix above at 0, 20, 35, 50 and 65% (w/w) of the 8% Job's tears blend before mixing, pasteurising, overnight chill storage, and ice cream making in that order.

#### **Sensory Property Measurement**

One hundred consumers were requested to evaluate the sensory attributes of the products, viz. colour (orange and yellow), hardness (the resistance of the ice cream to deformation when it is in the mouth), sweetness, saltiness, Job's tears flavour, coconut milk flavour, richness, carrot or pumpkin flavour, and smoothness, together with their overall preference of each product, by scoring each item on a 10-cm line scale (0 = least, 10 = most). After product evaluation, consumers were asked for their purchase intention before and after informing them about the nutritional and antioxidant capacity of the products.

# **Chemical Analysis**

Nutritional data, antioxidant capacity and total phenolic content of the ice cream of all three formulas (original, with 50% carrot juice, and with 50% pumpkin paste) were determined. Moisture, protein, fat, ash and crude fibre content were determined in accordance with AOAC methods [20] while carbohydrate content was calculated by subtraction. Antioxidant capacity was evaluated by 3 different methods, namely ferric reducing/antioxidative power (FRAP) assay [21], improved ABTS radical cation decolorisation assay [22], and DPPH free radical scavenging activity [23]. Total phenolic content was analysed by Folin-Ciocalteau micro method [24]. All analyses of antioxidant capacities and total phenolic content were done with some modification as previously described [17].

#### **Statistical Analysis**

Sensory-attribute rating scores of the products were reduced by principal component analysis (PCA) and the results were used to create a product positioning map. The equation for predicting preference direction was calculated from the product position and overall preference scores [25-27]. Overall preference and chemical analysis data were analysed by analysis of variance and Duncan's new multiple range test was applied to compare means. The McNemar test was used to compare the purchase intention before and after information concerning nutritional and antioxidant capacities of the products. All statistical analysis was done by SPSS 16.0 Family.

#### **RESULTS AND DISCUSSION**

# Job's Tears Ice Cream with Carrot Juice

Sensory attributes of the ice cream with carrot juice at different percentages were reduced by principal component analysis to 2 principal components (PCs) with 54.5% variance explained. A product positioning map was created on 2 PCs as shown in Figure 1. Sweetness, saltiness, Job's tears flavour, coconut milk flavour, richness and smoothness were related to PC1 with 28.3% variance explained, whilst orange colour, hardness and carrot flavour were related to PC2 with 26.2% variance explained. Addition of carrot juice thus affected the colour and hardness of the ice cream. Ice cream hardness, the resistance to deformation when an external force is applied, is affected by many factors such as overrun (amount of air in ice cream), ice crystal size, ice phase volume, fat content, fat globule destabilisation and temperature [28-30]. The addition of carrot juice

increased moisture content and decreased fat content of the ice cream (Table 5), which made the products harder.



PC 1 (28.3% variance explained)

**Figure 1.** Product positioning map of ice cream made from Job's tears mixed with carrot juice at 0, 25, 50, 75, and 100% (treatments 1–5 respectively; the number after each treatment is its mean overall preference score.) (Overall preference score = 4.78 + 6.14 PC1 + 2.58 PC2;  $r^2 = 0.87$ )

The equation for predicting preference direction, which was calculated from the overall preference data and product scores on PC1 and PC2 for this recipe, was a linear model: Overall preference score = 4.78 + 6.14 PC1 + 2.58 PC2. This means that the products located on the plus area of PC1 and PC2 would be preferred to products in other areas. Both Job's tears and carrot flavours made better products, but it was impossible to increase both of them at the same time. Since Job's tears was used as a main raw material and it affected the overall preference scores rather than carrot juice (the coefficient of PC1 (6.14), which is related to Job's tears flavour was higher than that of PC2 (2.58), which is related to carrot flavour), the quantity of carrot juice added should be considered.

An overall preference data showed that the products with 25 and 50% carrot juice were not significantly preferred (p>0.05) to that without carrot juice, while all of them were significantly

preferred ( $p \le 0.05$ ) to products with 75 and 100% carrot juice (Table 1). The addition of carrot juice at 25-50% did not significantly increase consumer preference but made the product different in colour and flavour (Figure 3). The composition with 50% carrot juice was then selected as suggested recipe for optimum health benefits from both the carrot and the Job's tears, and chemical analysis was performed on it.

Awareness on nutritional and antioxidant capacity of the products influenced the purchase intent. The number of consumers who had the intention to buy these products significantly increased ( $p \le 0.05$ ) from 70 to 88% (Table 2) after the nutritional and antioxidant capacity were explained. The awareness effect of a product's health benefits on the purchase intent of consumers was found previously, but the intent is also affected by other factors such as degree preference, product price, perceived value, and consumer characteristics [31-33].

 Table 1. Overall preference scores of Job's tears ice cream with carrot juice

Treatment	Score (mean $\pm$ SD)
1 (0% carrot juice added)	$5.61^{a} \pm 2.04$
2 (25% carrot juice added)	$5.74^{a} \pm 2.26$
3 (50% carrot juice added)	$6.11^{a} \pm 3.05$
4 (75% carrot juice added)	$4.90^{\rm b} \pm 1.83$
5 (100% carrot juice added)	$4.09^{\circ} \pm 2.09$

Note: Means with different letters were significantly different (p < 0.05). (0 = least preferred, 10 = most preferred)

**Table 2.** Number of consumers with intention to buy Job's tears ice cream with carrot juice

 before and after informing them about the nutritional and antioxidant capacity of the product

	Buy	Not buy	Total
Before informing	70	30	100
After informing	88	12	100

Note : McNemar test = 16.05 (p < 0.05)

#### Job's Tears Ice Cream with Pumpkin Paste

The principal component analysis of sensory attributes of Job's tears ice cream with added pumpkin paste at 0, 20, 35, 50 and 65% showed that these data could be reduced to 2 PCs with 43.3% variance explained. Both of them were used to create a product positioning map (Figure 2). Yellow colour, hardness and pumpkin flavour were related to PC1 with 22.8% variance explained,

whilst sweetness, saltiness, Job's tears flavour, coconut milk flavour, richness and smoothness were related to PC2 with 20.5% variance explained. This means that the addition of pumpkin paste affected the colour and hardness of the ice cream, which was similar to adding carrot juice. Pumpkin paste increased the moisture content of the products and made them harder, but there was no effect from the fat content (Table 5) because pumpkin flesh contains 1.5% fat [34].



PC 1 (22.8% variance explained)

**Figure 2.** Product positioning map of Job's tears ice cream with pumpkin paste at 0, 20, 35, 50, and 65% (Treatments 1-5 respectively; the number after each treatment is its mean overall preference score.) (Overall preference score =  $5.56 - 0.13 \text{ PC1}^2 - 3.96 \text{ PC2}^2$ ;  $r^2 = 0.75$ )

To predict preference inclinations, the overall preference data were regressed on PC scores of products. The equation for pumpkin paste recipe was an elliptical model: Overall preference score =  $5.56 - 0.13 \text{ PC1}^2 - 3.96 \text{ PC2}^2$ . This means that a product located at point (0,0) of PC1 and PC2 scores was most preferred, and a product at a minus or plus value of both PCs was less preferred. This kind of model showed that the addition of more or less quantities of pumpkin paste made the products less desirable.

The overall preference mean scores of the products with 35 and 50% pumpkin paste were almost equal to that without pumpkin paste. All of them were significantly preferred ( $p \le 0.05$ ) to

products with 20 and 65% pumpkin paste (Table 3). Although pumpkin paste addition did not significantly increase the consumer preference of Job's tears ice cream, adding pumpkin paste at 35 and 50% did make the products different in colour and flavour similar to adding carrot juice (Figure 3). The composition with 50% pumpkin paste was then selected as suggested recipe for optimum health benefits from both the pumpkin and the Job's tears, and chemical analysis was performed on it.

For purchase intent, the number of consumers who had the intention to buy the products significantly increased ( $p\leq0.05$ ) from 75 to 88% (Table 4) when consumers were informed about the nutritional and antioxidant capacity of the products. This result was similar to that on the carrot juice ice cream.

Treatment	Score (mean $\pm$ SD)
1 (0% pumpkin paste added)	$5.59^{a} \pm 2.14$
2 (20% pumpkin paste added)	$4.81^{b} \pm 2.35$
3 (35% pumpkin paste added)	$5.42^{a} \pm 2.24$
4 (50% pumpkin paste added)	$5.54^{a} \pm 2.08$
5 (65% pumpkin paste added)	$4.62^{b} \pm 2.37$

Table 3. Overall preference scores of Job's tears ice cream with pumpkin paste

Note : Means with different letters in the same column were significantly different (p<0.05). (0 = least preferred, 10 = most preferred)

**Table 4.** Number of consumers with intention to buy Job's tears ice cream with pumpkin paste before and after informing them about the nutritional and antioxidant capacity of the product

	Buy	Not buy	Total
Before informing	75	25	100
After informing	88	12	100

Note : McNemar test =  $8.47 (p \le 0.05)$ 



**Figure 3.** Job's tears ice cream (white – original; orange – with carrot juice; yellow – with pumpkin paste)

# **Chemical Analysis**

Nutritional data, antioxidant capacity and total phenolic content of selected ice cream products are shown in Table 5. Job's tears ice cream with 50% carrot juice contained more moisture, ash and total phenolics, but less fat, carbohydrate and crude fibre than the original Job's tears ice cream. The antioxidant capacity of the ice cream with carrot was found to be lower than that of the original product. Similarly, the ice cream with 50% pumpkin paste contained more moisture, crude fibre and total phenolics, and less carbohydrate than the original ice cream. The ABTS value of the ice cream with pumpkin was observed to be higher, while the FRAP and DPPH values lower, than the corresponding values of the original product. This difference was possibly due to the different mechanisms involved in the reactions in the three methods. The FRAP assay measures the total reducing power of electron donating substances [21] whilst ABTS and DPPH assays are based on the ability of antioxidant molecules to quench ABTS radical cation [22] or DPPH free radical [23]. Phenolic compounds in Job's tear, carrot and pumpkin are different [11, 18-19] and most likely there are other compounds in these ingredients which also possess antioxidant activity. These phenolic and other compounds in Job's tears, carrot and pumpkin could provide other health benefits as well.

The lowest value of antioxidant capacity in this study was 26.50 mg vitamin C equivalent/100 grams, which is more than 40% of the daily value (60 mg) of vitamin C [35]. Vitamin C is one of the antioxidant vitamins used for claims of antioxidant nutrient content. A product must contain 20% or more of the daily value of vitamin C, vitamin E, or  $\beta$ -carotene for the claim of 'high in antioxidant vitamin C, vitamin E, or  $\beta$ -carotene' [36]. Although other ingredients are not allowed to be used for this antioxidant claim, a comparison of the antioxidant capacity of a product with such antioxidant vitamins as vitamin C may be used to express the product's antioxidant potential.

	Job's tears ice cream	Job's tears ice cream with 50% carrot juice	Job's tears ice cream with 50% pumpkin paste
Moisture (%w/w)	$67.66^{\circ} \pm 0.36$	$72.24^{a}\pm0.23$	$71.07^{b}\pm0.03$
Protein (%w/w) <sup>ns</sup>	$1.00\pm0.06$	$0.88\pm0.05$	$0.98\pm0.01$
Fat (%w/w)	$0.48^{a}\pm0.12$	$0.17^{b}\pm0.09$	$0.43^a\pm0.12$
Ash (%w/w)	$0.34^{\text{b}}\pm0.01$	$0.40^a\pm0.01$	$0.35^{\text{b}}\pm0.01$
Carbohydrate (%w/w)	$30.52^{a} \pm 0.56$	$26.3^{\circ} \pm 0.06$	$27.17^{b} \pm 0.09$
Crude fibre (%w/w)	$0.04^{\text{b}}\pm0.01$	$0.02^{c} \pm 0.01$	$0.07^{a}\pm0.01$
FRAP (mg vitamin C equivalent /100 grams product)	$47.12^{a} \pm 2.63$	$26.50^{\circ} \pm 3.13$	$30.4^{\text{b}} \pm 1.38$
ABTS (mg vitamin C equivalent /100 grams product)	$228.54^{b} \pm 20.48$	$94.38^{\circ} \pm 8.64$	$372.15^{a} \pm 32.13$
DPPH (mg vitamin C equivalent /100 grams product)	$251.38^{a} \pm 8.61$	$209.20^{b} \pm 20.36$	$192.80^{\rm b} \pm 15.24$
Total phenolic content (mg gallic acid equivalent /100 grams product)	$9.06^{\circ} \pm 0.07$	$25.14^{a} \pm 1.83$	$15.21^{b} \pm 0.42$

**Table 5.** Nutritional data, antioxidant capacity and total phenolic content (mean  $\pm$  SD) of Job's tears ice cream

Note : Means with different letters in the same row were significantly different ( $p \le 0.05$ ).

 $^{ns}$  = There is no significant difference (p>0.05).

#### CONCLUSIONS

It has been shown that consumers' acceptance of the original and the two new flavours of Job's tears ice cream developed in this study is similar. Although the antioxidant capacity of Job's tears ice cream with carrot juice or pumpkin paste may be somewhat lessened, this is compensated by a higher phenolic content and a lower carbohydrate content, and all formulas can be considered as antioxidant products.

The development of Job's tears ice cream is an approach to promoting the consumption of Job's tears because ice cream is a popular product for people, especially in tropical areas like Thailand. Incorporation of carrot juice and pumpkin paste into the recipe makes Job's tears ice cream more colourful and varied in flavour as well as in health benefits, which may be more attractive to consumers.

# ACKNOWLEDGEMENTS

This work is a part of a research project supported by a grant from the Faculty of Engineering and Agro-Industry, Maejo University.

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