Development of Yogurt Drink using Carrot (*Daucus Carotta L.*) Juice.

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Abstract

Yogurt products are increasing in popularity in many countries and have been marketed and modified successfully in beverage industry. This research was carried out to develop yogurt drink using carrot (*Daucus Carota L.*) juice by determine best formulation, proximate analysis, keeping quality and consumer acceptance. Keeping quality analysis was conducted through physicochemical, microbiological and sensory test by using multiple comparison test with 8 different variables (F1-F8). The best formulation was formulation F8 with proximate analysis of 78.02 ± 4.91% moisture, 1.40 ± 0.015% protein, 1.0 ± 0.01% fat, 0.39 ± 0.01% ash, 1.15 ± 0.05% crude fibre and 19.02 ± 4.90 % carbohydrate content. There was an increasing level of sensory changes in the yogurt drink for colour, aroma, taste, texture, sourness, sweetness, aftertaste and overall acceptance of 3 weeks (4 ± 1°C) storage period that indicate that the yogurt drink was acceptable. Microbiological testing of the yogurt drink using carrot juice indicated that there were low presence of bacteria and yeast and mould at the first week of the storage period but gradually increased throughout the storage. The presence were not exceed the standard and safe to be consumed. It was found that 75.50% of the consumers responded that they were willing to purchase the product.

Keywords: carrot, yogurt drink, probiotic

1. Introduction

Yogurt drink is one of the dairy products that are among the fastest beverage and commonly consumed around the world. It is defined as a dairy-based yogurt that is drinkable and in a liquid form that may or may not include fruit or fruit flavouring (Matitila-Sandholm and Saarela, 2003). It is proved that yogurt drink sales is the most lucrative for the Malaysian yogurt market in 2010 (MIDA 2011).

Yogurt is a conventional beverage known for its therapeutic, nutritional and sensory properties (Gonzalez et *al.*, 2011). Yogurt is prepared by fermentation of milk with bacterial cultures consisting of a mixture of *Streptococcus subsp. thermophilus* and *Lactobacillus delbrueckii subp.*

bulgaricus (Lee and Lucey, 2010). These microorganisms metabolizes some of milk sugar (lactose) into lactic acid and flavor compounds such as acetaldehyde, carbon dioxide and diacetyl. Popularity of yogurt products continues due to its health benefits. It is rich in calcium, phosphorus and potassium which are essential for the development and maintenance of bones. Besides, yogurt drink is a better source of these minerals than milk due to the fact that yogurt was produced from milk that has been enriched.

The health benefits of yogurt are also incorporated with the presence of lactic acid bacteria in the yogurt (Matitila-Sandholm and Saarela, 2003). Lactic acid bacteria is beneficial on the gut health as it can protect against enteric infection and inhibit chemically carcinogens in the gastrointestinal tract (Ayman and Omer, 2009). The objectives of this research were to produce best formulation of yogurt drink incorporated with carrot (*Daucus carota L.*) juice based on sensory evaluation, proximate analysis and keeping quality. Since the market potential for healthy product is arise, the production of yogurt drink using carrot juice was investigated.

2. Materials and method

2.1 Materials used

Carrots were purchased at the supermarket. Other materials such as the freeze-dried starter culture, pasteurized milk, pectin, skimmed milk powder and sugar was obtained from Sabah International Diaries Sdn. Bhd.

2.2 Experimental design

Table 1: The formulation of drinking yogurt using carrot juice.

Formulation	**Yogurt base (%)**	**Pectin (%)**	**Carrot pure (%)**	**Sugar (%)**	**Water (%)**
F1	40		10	3.4	46
F2			10	3.8	45.6
F3			12	3.4	44
F4			12	3.8	43.6

F5	45	0.6	10	3.4	41
F6			10	3.8	40.6
F7			12	3.4	39
F8			12	3.8	38.6
F9	50		10	3.4	36
F10			10	3.8	35.6
F11			12	3.4	34
F12			12	3.8	33.6
F13	55		10	3.4	31
F14			10	3.8	30.6
F15			12	3.4	29
F16			12	3.8	28.6

2.3 Preparation of yogurt base

Preparation of yogurt was based on the standardization of milk solid non fat in the pasteurized milk as described by Allgeyer *et* al. (2010). The milk fat and milk solid non fat was standardized through milk solid non fat (MSNF) formula as shown in Equation 3.0. All the ingredients were weighed and pasteurized with a moderate temperature of 80 ± 5°C for 30 minutes and were cooled down to 40 ± 5°C. Since the starter culture used was direct-to-vat cultures, the starter culture was inoculated at 40 ± 5°C. The pH value and the acidity of solution were determined for every 30 minutes until it reached pH range within 4.2 to 4.6 and acidity range within 0.90 to 0.95. The yogurt culture was stored at 4 ± 1°C and left overnight.

Milk solid non fat (MSNF) =
0.25 (D) + 0.22 F + 0.72 ---------- (3.0)

Where, D = (Specific gravity - 1) x 1000

F = Milk fat content

2.4 Preparation of carrot juice

Fresh carrot was washed with tap water. Carrot juice was prepared from fresh carrots by crushing it in blender (Panasonic model MX-337) and the juice was pasteurized at 85 ± 5°C for 10 minutes as described by Cliff *et* al. (2013).

2.5 Preparation of yogurt drink

Yogurt drink was prepared as described by Allgeyer *et* al. (2010). The amount of yogurt base, stabilizer, sugar, carrot juice and water were weighed according to the formulation. The mixtures were mixed using blender for 3 minutes until all of the ingredients were well mixed. The solution was heated at 75 ± 5°C for 15 seconds and was stored at 4 ± 1°C.

2.6 Sensory test to select best formulation

A few best formulations was selected to run the hedonic test as described as Aminah (2000). Hedonic test with seven scales was carried out among 40 trained panellist of Food Science and Nutrition Students, Universiti Malaysia Sabah. Sensory attributes tested including colour, flavour, aroma, texture, aftertaste and overall acceptance. The panellists was evaluate these attributes based on their preferences by using 7 scales (1= Very dislike, 4= Neither like nor dislike, 7=Very like).

2.7 Proximate analysis

Proximate analysis for determination of moisture content, crude fibre, ash, fat, protein and carbohydrate content were conducted for the final formulation of yogurt drink using carrot juice. Methods that were used were based on Association of Official Analytical Chemists (AOAC, 2000).

2.8 Keeping quality analysis

The final product was kept for 3 weeks at 4 ± 1 °C. The quality of the product during storage was studied that involved the physicochemical test, microbiological test and sensory test.

2.8.1. Physicochemical test

Physicochemical analysis for drinking yogurt was involved determination of pH value, acidity, total solid soluble and measurement of syneresis that was conducted in triplicate.

a. Determination of pH value
   Five ml of the sample was taken and the pH value was determined by using a pH meter (Mettler Toledo model MP 220). The reading obtains were recorded.

b. Determination of acidity
   The acidity was determined through a titration process of the 10 ± 0.01 ml of sample with 0.1 N of sodium hydroxide (NaOH) and by the aid of 5 drops of phenolphthalein until the solution changes its colour from pink to colourless as described by Joseph and Oseh (2011). The percentage of acid lactic was determined by using the formula as shown in Equation 3.1.

$$\text{Percentage of lactic acid (\%)} = \frac{N \times V \times 0.09 \times 100}{W} \quad \text{---- (3.1)}$$

Where, N = Normality of alkali
V= Volume (ml) of NaOH used
W= Volume (ml) of the sample

c. Determination of total solid soluble (° Brix)
   Total solid soluble was determined by using ATAGO Hand Refractometer (Model N-1E, 0-32% Brix). The little yogurt drink sample was applied on refractometer prism and the prism cover closed. The refractometer was directed towards a bright light and the reading was taken on the divisions in the refractometer.

d. Measurement of syneresis (whey separation)
   Whey that separated from samples during storage was measured. The method was adopted from Kumar and Mishra (2004) in which 30 ± 0.01 ml of sample was placed into centrifuge tubes and was centrifuged by using a centrifuge machine (Kubota 2100) at 100 g for 10 minutes. Syneresis was counted as a separate supernatant mass of the total mass used in the centrifugation

yogurt. Syneresis was calculated by using the formula as shown in Equation 3.2.

$$\text{Syneresis (\%)} = \frac{V}{W} \times 100\% \text{---------- (3.2)}$$

Where, V = Volume of supernatant (ml)
W= Volume of sample (ml)

e. Measurement of viscosity
According to Gonzalez *et* al. (2011), dynamic viscosity of each sample was measured by using a rotational Viscometer meter (DV-II digital Viscometer, Brookfield Engineering Laboratories, Inc). All measurements were done at room temperature (24 ± 1 °C) using a number 3 spindle set at 50 rpm.

2.8.2. Microbiological test

The microbiological analysis was carried out every week on the final selected sample through standard plating method using De Man, Rogosa and Sharpe (MRS) agar for lactic acid count, Plate Count Agar (PCA) agar for viable count and Potato Dextrose Agar (PDA) agar for yeast and mould count after incubation for 48 hours at temperature of 37°C as described by Chandan & Kilara (2011).

2.8.3. Sensory test

Hedonic test with seven scales was carried out among 40 trained panellist of Food Science and Nutrition students, Universiti Malaysia Sabah. Sensory attributes tested including colour, flavour, aroma, texture, aftertaste and overall acceptance. The panellists was evaluate these attributes based on their preferences by using 7 scales (1= Very dislike, 4= Neither like nor dislike, 7=Very like).

2.9. Consumer test

Consumers test that was carried out is to investigate the acceptance of yogurt drinks by using carrot juice among consumers from various ages, gender and race. This test was conducted at One Borneo Hypermall by a total of 104 panels that were randomly selected. In consumers testing, the level of consumers' acceptance of yogurt drink using carrot juice

was studied. Consumers were asked to test the best formulation of yogurt drinks sample and evaluate it according to their own preferences.

2.10. Statistical analysis

All of the sensory data, physiochemical analysis, colony counts and proximate analysis was analysed through Statistic Package for Social Sciences (SPPS) version 20.0 by using one-way analysis of variance test (ANOVA) at a significant level of $p \leq 0.05$ to determine the differences among the parameters. The differences between the samples was analysed by using Turkey test.

3. Findings

There were 16 formulations of yogurt drink that have different percentages of yogurt base (40%, 45%, 50% and 55%), carrot juice (12% and 14%) and different percentages of sugar level (8% and 6%). The best formulation chosen using hedonic scale test based on the sensory evaluation that was formulation F8 with 45% of yogurt base, 14% of carrot juice, 8% of sugar, 0.6% of pectin, 0.1% of vanilla essence and 32.3% of water.

The proximate results showed that the product contain 78.02 ± 4.91% of moisture, 1.40 ± 0.015% of protein, 1.0 ± 0.01% of fat, 0.39 ± 0.01% of ash, 1.15 ± 0.05% of crude fibre and 19.02 ± 4.90% of carbohydrate. The percentage of protein and fat content in the yogurt drink using carrot juice were lower compared to the value of both the protein and fat content produced by Santiago *et* al. (2007). However, a study conducted by Manzi *et* al. (2007) showed higher value for crude fibre, moisture, carbohydrate and ash content compared to the yogurt drink using carrot juice.

The final product was kept for 3 weeks at 4 ± 1 °C to check for any changes in physicochemical, microbiological and sensory properties (Table 2). There was an increasing mean score of sensory changes in the yogurt drink for colour, aroma, taste, texture, sourness, sweetness, aftertaste and overall acceptance within the storage period that indicate that the yogurt drink was acceptable for 3 weeks storage period 2.

The sensory test result showed that there were significant differences ($p<0.05$) among all of the attributes with a fresh sample start at second week onwards. This indicates that for all of the attributes there were no differences with the fresh sample up to week 2. Based on the score value, most panellists

were interested with the colour, aroma and texture of the yogurt drink up to week 3 compared to other attributes. The changes of colour occurred due to the fermentation reaction in yogurt drink that making the conversation of lactose to lactic acid. During this process, pH declines and reaches the average isoelectric point of caseins; this will change the milk ultra-structure and modifying milk colour (Mehta *et* al., 2004). For the aroma attribute, lactic acid bacteria (LAB) may contribute to the changes of aroma to the product. The main activity of the microbial group is the utilization of the carbohydrates that are fermented, giving rise to lactic acid (Mehta *et* al., 2004). Besides, LAB may also produce aromatic compounds such as acetate, diacetyl, acetoin and acetaldehyde may affect the flavour of drinking yogurt. The aroma of carrot also influenced the aroma of yogurt drink using carrot juice. The distinctive aroma of carrots is due to largely to terpenes. The sweet aroma of carrot is due to damage of stronger cell walls during processing and frees the sugar taste in the carrot (McGee, 2004). For texture attribute, majority of the panellists were like yogurt drink that is less viscous and more watery. According to Whitaker (1978), the lactic acid bacteria (LAB) presence in the yogurt drink may also affect the texture of the sample. LAB is able to produce polysaccharides called exopolysaccharides (EPS) which act as thickening agents. It exhibits thickening properties that significantly decrease in viscosity during shaking, mixing or pouring.

Table 2: The sensory test results within 3 weeks of storage period[1]

Storage Period	**Colour**	**Aroma**	**Taste**	**Texture**	**Sour-ness**	**Sweet -ness**	**After taste**	**Overall Accep-tance**
Week 0	$4.00^{a} \pm 0.00$	$4.00^{a} \pm 0.00$	$4.00^{a} \pm 0.00$	$4.00^{a} \pm 0.00$	$4.00^{e} \pm 0.00$	$4.00^{a} \pm 0.00$	$4.00^{a} \pm 0.00$	$4.00^{a} \pm 0.00$
Week 1	$4.25^{a} \pm 0.44$	$4.14^{a} \pm 0.49$	$4.24^{a} \pm 0.00$	$4.36^{a} \pm 0.49$	$4.12^{a} \pm 0.51$	$4.07^{a} \pm 0.44$	$4.10^{a} \pm 0.49$	$4.12^{a} \pm 0.42$
Week 2	$4.75^{b} \pm 0.77$	$4.56^{a} \pm 0.61$	$4.45^{a} \pm 0.00$	$5.19^{b} \pm 0.77$	$4.34^{b} \pm 0.10$	$4.13^{a} \pm 0.51$	$4.24^{b} \pm 0.76$	$4.29^{b} \pm 0.51$
Week 3	$5.44^{c} \pm 0.50$	$5.01^{b} \pm 0.49$	$4.49^{b} \pm 0.00$	$5.67^{c} \pm 1.00$	$4.54^{c} \pm 0.35$	$4.28^{b} \pm 0.45$	$4.32^{b} \pm 0.48$	$4.35^{b} \pm 0.75$

[1]Means in the same column with different superscript are significantly different at ($p<0.05$).

Physicochemical test includes determination of pH, acidity, syneresis, viscosity and total solid soluble. Results of physicochemical analysis showed that there is an increase of acidity value and total soluble solid and decrease of pH and viscosity value for every week as shown in Table 3. These changes of pH and acidity may be due to the post-acidification phenomenon caused by lactic acid cultures in which some of culture strain may continue to produce acid during storage (Hutkins, 2006). While the increasing in total soluble solid is usually the best predictor for the progress of lactic acid fermentations in yogurt (Nielsen, 2009). Thus, the value of total soluble solid was directly proportional to the value of acidity in the yogurt drink.

Table 3: Physicochemical changes during storage period[1].

Storage Period	**pH**	**Acidity (%)**	**Viscosity (mPas)**	**Syneresis (%)**	**Total soluble solid (°Brix)**
Week 0	$4.49^{a} \pm 0.01$	$0.36^{a} \pm 0.01$	$42.0^{a} \pm 0.49$	0	$9.00^{a} \pm 0.01$
Week 1	$4.47^{a} \pm 0.01$	$0.54^{b} \pm 0.01$	$35.0^{a} \pm 1.42$	0	$11.0^{b} \pm 0.01$
Week 2	$4.45^{a} \pm 0.01$	$0.68^{c} \pm 0.01$	$32.0^{a} \pm 0.15$	0	$12.0^{c} \pm 0.01$
Week 3	$4.41^{a} \pm 0.01$	$0.62^{c} \pm 0.01$	$30.0^{a} \pm 0.26$	0	$12.0^{c} \pm 0.01$

[1]Means in the same column with different superscript are significantly different at ($p<0.05$).

Syneresis defined as the shrinkage of gel, this occurs concomitantly with expulsion of liquid or whey separation, and it is related to instability of the gel network resulting in the loss of the ability to entrap all the serum phase (Magenis *et* al., 2006). Kiani *et* al. (2010) reported that the lower the syneresis, the better the quality of yogurt drink it is. Since there is no syneresis occurred, this shows that the yogurt drink is in a good quality within the storage period.

Microbiological test showed the constantly increasing of total colony growth of bacteria, yeast and mould but still did not exceed the maximum level for total plate count (10^{7} to 10^{9} cfu/ml) and for yeast and mould count (5×10^{1} cfu/ml) (Table 4). It was still safe to consume. The total colony growth of lactic acid bacteria decreased within the week but still above the minimum of lactic acid bacteria (10^{6} cfu/ml) that is still able to provide the desired

health or nutritional benefits for consumers. The reduced level of lactic acid bacteria resulted in slightly higher post-acidification, which was found to have adverse effect on viability of probiotic organisms (Dave, 1998).

Table 4: Colony count (cfu/ml) for yogurt drink using carrot (*Daucus Carota* L.) juice.

Keeping period	**MRS**	**PCA**	**PDA**
0 week	155×10^9	13×10^1	ND*
1 week	145×10^8	11×10^2	1×10^1
2 week	129×10^7	12×10^4	2×10^1
3 week	102×10^6	9×10^5	4×10^1

* ND: Not detected, MRS: deMan, Rogosa and Sharpe agar, PCA: Plate count agar, PDA: Potato dextrose agar

It was found that 75.50% of the consumers responded that they were willing to purchase the product. It is showed that consumers were like all the attributes of the yogurt drink since has a higher percentage of buying potential in the market.

4. Conclusion

In order to develop yogurt drink using a carrot (*Daucus Carota L.*) juice that was well accepted among consumers, formulation F8 was selected as the best formulation based on the highest rate of overall liking among the consumers. Formulation F8 consists of 45% yogurt base, 14% carrot juice and 8% sugar. Proximate analysis of yogurt drink using carrot juice showed that the product contained 78.02 ± 4.91% of moisture, 1.40 ± 0.015% of protein, 1.00 ± 0.01% of fat, 0.39 ± 0.01% of ash, 1.15 ± 0.05% of crude fibre and 19.02 ± 4.90% of carbohydrate. There was an increasing level of sensory changes in the yogurt drink for colour, aroma, taste, texture, sourness, sweetness, aftertaste and overall acceptance of the storage period that indicate that the yogurt drink was acceptable for 3 weeks storage period. The microbiological testing of the yogurt drink using carrot juice indicated that there were little presence of bacteria and yeast and mould at the first week of the storage period but gradually increased throughout the three weeks of the storage period at 4 ± 1°C. However, their presence were still did not exceed the standard requirement and was still safe to consume. In the determination of the market value of the yogurt drink using carrot juice, it was found that consumers were prefer all the attributes of the yogurt drink with the range of 6.19 ± 0.87 to 7.10 ± 0.65 of the mean score value of colour, taste, aroma, texture, sourness, sweetness and aftertaste attributes of the drinking yogurt.

It was found that 75.50% of the consumers responded that they were willing to purchase the product.

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