DEVELOPMENT OF YOGURT DRINK USING CARROT (*DAUCUS CAROTA* L.) JUICE

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE BACHELOR OF FOOD SCIENCE WITH HONOURS (FOOD SCIENCE AND NUTRITION)

SCHOOL OF FOOD SCIENCE AND NUTRITION
UNIVERSITI MALAYSIA SABAH
2013

PUMS 99:1

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: DEVELOPMENT OF YOGURT DRINK USING CARROT (DAUCUS CAROTA L.) JUICE.

IJAZAH: IJAZAH SARJANA MUDA SAINS MAKANAN DENGAN KEPUJIAN (SAINS MAKANAN DAN PEMAKANAN)

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ACKNOWLEDGEMENT

Foremost, I would like to express my sincere gratitude to my supervisor Dr. Muhammad Iqbal Hashmi of the School of Food Science and Nutrition, Universiti Malaysia Sabah for his support of my Bachelor Degree study and research, for his patience, enthusiasm and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

Besides my supervisor, I would like to thank the rest of my lecturers for all the guidance and lead me to finish my thesis step by step. What I learn from my lecturers is not just how to write the thesis to meet the graduation requirement, but how to view this world from a new perspective.

I am also indebted to my friends and my course mates, who squeeze time from their busy schedule to help me finish my thesis. Besides, I also want to thank all the lab assistance and all SSMP's staff for their cooperation and support for helping me prepare all the materials.

Finally, I am grateful to my family especially my parents Abdul Hajis B. Hj. Saipuddin and Supiah Hj. Noor, who always support in terms of motivation and financial to finish my thesis. Although they hardly understand what writing thesis is and what I research on, my parents are willing to support any decision I make.

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ABSTRACT

This research was carried out in order to develop yogurt drink using carrot (*Daucus carota* L.) juice. 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 3 formulations from 16 formulations were selected using a ranking test. A best formulation was chosen using hedonic scale test based on the sensory evaluation. A best formulation is 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. Proximate analysis was carried out to determine the percentage of moisture, ash, fat, protein, crude fibre and carbohydrate. The 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 content. 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 in the yogurt drink conducted by several studies. The value of crude fibre, moisture, carbohydrate and ash content in the sample were nearly the same with several studies on the moisture and ash content in the yogurt drink. However, some studies did show higher value for crude fibre, moisture, carbohydrate and ash content in the yogurt drink compared to the yogurt drink using carrot juice. 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 using multiple comparison test. 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. 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 solid soluble and constantly decrease of pH and viscosity value every week. The syneresis of yogurt drink remains constant for every week. However all of the results of the physicochemical analysis were still meet the standard and value of other related studies. 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). It was still safe to consume. The total colony growth of lactic acid bacteria was 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 market value of the yogurt drink using carrot juice showed that consumers were like all the attributes of the yogurt drink and has a higher percentage of buying potential in the market.

ABSTRAK

PEMBANGUNAN MINUMAN YOGURT MENGGUNAKAN JUS LOBAK MERAH (DAUCUS CAROTA L.)

Kajian ini dijalankan untuk menghasilkan minuman yogurt dengan menggunakan jus lobak merah (Daucus carota L.). Terdapat 16 formulasi untuk minuman yogurt yang mempunyai peratusan yogurt asas yang berbeza (40%, 45%, 50% and 55%), jus lobak (12% and 14%), peratusan gula yang berbeza (8% and 6%). Tiga formulasi terbaik daripada 16 formulasi telah dipilih dengan menggunakan ujian pemeringkatan. Satu formulasi terbaik yang dipilih melalui ujian skala hedonik ialah formulasi F8 yang mempunyai 45% yogurt asas, 14% jus lobak, 8% gula, 0.6% pektin, 0.1% perasa vanilla dan 32.3% air. Analisis proksimat telah dijalankan untuk menentukan peratus kandungan lembapan, abu, lemak, protein, serabut kasar dan karbohidrat. Keputusan menunjukkan produk mengandungi 78.02 ± 4.91% kandungan lembapan, 1.40 ± 0.015% protein, 1.0 ± 0.01% lemak, 0.39 ± 0.01% abu, 1.15 ± 0.05% serabut kasar dan 19.02 ± 4.90% karbohidrat. Peratusan kandungan protein dan lemak lebih rendah berbanding beberapa kajian lain. Peratusan serat kasar, lembapan, karbohidrat dan kandungan abu adalah sama dengan beberapa kajian lain namun terdapat juga kajian menunjukkan peratusan yang tinggi berbanding dengan sampel minuman yogurt menggunakan lobak merah. Sampel terbaik telah disimpan selama 3 minggu dalam suhu 4 ± 1°C. Kajian mutu simpanan melibatkan ujian fizikokimia, ujian mikrobiologi dan ujian sensori dengan menggunakan ujian perbandingan berganda. Terdapat peningkatan terhadap skor min sampel iaitu bagi atribut warna, rasa, tekstur, kemasaman, kemanisan, 'aftertaste' dan penerimaan keseluruhan yang menunjukkan minuman yogurt diterima oleh pengguna untuk 3 minggu tempoh penyimpanan. Ujian fizikokimia melibatkan penentuan pH, keasidan, sineresis, kelikatan dan jumlah pepejal larut. Hasil menunjukkan peningkatan terhadap keasidan minuman yogurt dan jumlah pepejal larut. Selain itu, nilai pH dan viskositi menurun setiap minggu sewaktu tempoh penyimpanan. Sineresis minuman yogurt pula tidak berubah sepanjang minggu. Akan tetapi, keputusan bagi semua analisis fizikokimia masih mencapai piawaian dan nilai yang hampir sama dengan kajian yang lain. Hasil ujian mikrobiologi menunjukkan terdapat peningkatan terhadap pertumbuhan jumlah koloni bagi bakteri, yis dan kulat. Namun, masih selamat untuk diminum kerana tidak melebihi tahap maksima untuk jumlah kiraan plat (10^7 hingga 10^9 cfu/ml) dan kiraan jumlah koloni untuk kiraan yis dan kulat (5 x 10^4 cfu/ml). Pertumbuhan jumlah koloni untuk bakteria asid laktik menurun setiap minggu namun masih berada di atas tahap minimum untuk bakteria asid laktik (10^6 cfu/ml) yang masih mampu untuk memberi kebaikan nutrisi terhadap pengguna. Nilai pasaran minuman yogurt menggunakan jus lobak merah juga menunjukkan pengguna menyukai semua atribut dan mempunyai peratusan potensi yang tinggi untuk dibeli di pasaran.

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kg	kilogram
pH	potential of hydrogen
°C	degree Celcius
cm	centimetre
g	gram
%	percentage
mg	milligram
cal	calories
ml	millilitre
m/m	mass over mass
≤	less than
≥	more than
±	until
cfu	colony form unit
TA	Titratable Acidity
LAB	Lactic acid bacteria
CAGR	Compound annual growth rate
ANOVA	Analysis of Variance
SPSS	Statistical Package for Social Science

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

Yogurt drink is one of the dairy products that were the fastest growing food and beverage sector purchased 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 a conventional food 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). It metabolizes some of the milk sugar (lactose) in the milk into lactic acid and flavour compounds such as acetaldehyde, carbon dioxide and diacetyl. Popularity of yogurt products continues due to its health benefits. It is rich in calcium, phosphorus, relatively large amount of potassium and can also be considered as a good source of potassium both of which are essential for the development and maintenance of bones. 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 (LAB) are a group of gram-positive bacteria that have special morphological, metabolic and physiological characteristics which produce lactic acid as the main fermentation products of carbohydrates (Matitila-Sandholm and Saarela, 2003). One of the functions of LAB in the intestinal microflora is to help in the absorption of indigestible nutrients through fermentation and modulate antigen uptake (Farnworth, 2008).

The yogurt drink industry in Malaysia is becoming increasing dense. Increasing consumer awareness in nutrition value and food fortification for health are creating demand for functional or healthy minimally processed fresh food, dairy product, organic food and natural food flavours from plants and seafood (MIDA, 2011). Yogurt products are increasing in popularity in many countries and have been marketed and modified successfully in the beverage industry (Gonzalez *et al.,* 2011). It is proved that yogurt drink sales are the most lucrative for the Malaysian yogurt market in 2010 (MIDA 2011). Due to the larger production area, the markets in Asia are becoming geographically larger and transport distances are much longer (Sinha, 2007).

Rising sophistication of the yogurt industry in terms of demand suggests that more value-added health benefits are likely to be incorporated into yogurt over the forecast. Besides, more new taste and flavours also need to be introduced in Malaysia, reflecting the manufacturers' aim of attracting more consumers (Ibp, 2013). Fermented dairy products including yogurt have a positive health image. Growing worldwide popularity of this type of product can be also due to the effective use of consumers-driven flavours, addition of fruits and milder cultures (Escamilla *et al.*, 2005).

Carrots (*Daucus carota* L.) are one of the most selected vegetable because of their versatility in culinary use and its enriched healthy composition such as phytonutrients, and minerals (Goncalves *et. al.,* 2010). It is rich in functional food components such as vitamins (A, B, C, D, E, and K) and minerals (calcium, potassium, phosphorus sodium and iron). Carrots are biennial and belong to the genus *Daucus* and the species *Carota* (Asworth, 2002).

Carrot juice is defined as liquid part that can be extracted from plant or animal tissue by squeezing or cooking (Patterson *et al.,* 2012). Fruit juice probiotic beverages became an important category because they have taste profiles that are appealing to all groups and because they are perceived as healthy and refreshing foods (Hui, 2012).

The development of carrot juice in the probiotic beverage industry presented an interest in the development of fruit-based functional beverages with probiotics as line extensions of existing functional drinks.

The application of carrot juice in probiotic beverages plays an important role to give a carrot taste appealing to the product (Hui, 2012). Carrot juice is more preferable than dehydrated carrot in which several deteriorative reactions that affect the colour, nutrient properties, texture and flavour of dehydrated carrots are initiated during processing and dehydration operations (Koca *et al.,* 2005). Degradations of carotenoids will not only affect the attractive colour of foods but also their nutritive value and flavour. Non enzymatic browning may also occur that will produce dark-coloured pigments in food during processing and storage. Thus, carrot juice that still reserves the nutrient content and other components in the carrot is more preferable in the beverages compared to the dehydrated carrot (Koca *et al.,* 2005).

According to Kun *et al.* (2008), carotenoids and other antioxidants that present in carrot play an important role in the inhibition and interruption of oxidation process that is also important in counterbalancing free radical activities. Since the market potential for healthy product is arise, the production of yogurt drink using carrot juice was investigated.

1.2 Objectives of the study

1. To produce best formulation of yogurt drink using a carrot (*Daucus carota* L.) juice through the sensory evaluation test.
2. To determine the proximate analysis for yogurt drink using carrot (*Daucus carota* L.) juice.
3. To investigate the keeping quality of yogurt drink using carrot (*Daucus carota* L.) juice through sensory analysis, physicochemical analysis and microbiological analysis within the storage period.

4. To investigate the consumers acceptance yogurt drink using carrot (*Daucus carota* L.) juice.

CHAPTER 2

LITERATURE REVIEW

2.1 Yogurt

Fermented dairy foods have constituted a vital part of human diet in many regions of the world. Historically, products derived from fermentation of milk of various domesticated animals resulted in conservation of valuable nutrients. Conversion of milk to fermented milk resulted in the generation of a distinctive viscous consistency smooth texture and unmistakable flavour (Smith and Hui, 2004). Fermentation provides food safety, portability, and novelty for the consumers (Hui *et al.*, 2005). The diversity of fermented milks may be ascribed to the use of milk obtained from various domesticated animals, application of diverse microflora, addition of sugar, condiments, grains and fruits (Hui *et al.*, 2005).

Yogurt is defined as a fermented food that produced by culturing one or more of the optional dairy ingredients with a bacterial culture that contains the lactic acid-producing bacteria *Lactobacillus bulgaricus (Lb. bulgaricus)* and *Streptococcus thermophilus (S. thermophilus)* (Hui *et al.*, 2005). Commonly, 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). The fermentation process involves the transformation of simple raw materials into a range of value-added products by utilizing the phenomena of the growth of microorganisms and their activities on various substrates (Farnworth, 2008).

This fermentation process will metabolize some of the milk sugar (lactose) in the milk into lactic acid and flavour compounds such as acetaldehyde, carbon dioxide and diacetyl (Matitila-Sandholm and Saarela, 2003).

According to Tamime and Robinson (2000), yogurt come in a variety of textures (liquid, set and smooth), fat contents (luxury, low liquid, virtually fat free) and flavours (natural, fruit, cereal) that can be consumed as a snack or part of a meal, as a sweet or savoury food, and are available all around the world. Industrially, yogurt can be largely divided into two types that are set yogurt and stirred yogurt (Haque *et al.*, 2001). A set yogurt is made in retail containers, giving a continuous undisturbed gel structure in the final product. On the other hand, stirred yogurt has a delicate protein gel structure that develops during fermentation where fermentation is carried out in large tanks and the acid gel is then disrupted by stirring and sieving to give a more fluid product which is often used as a base for inclusion on fruit before packaging (Haque *et al.*, 2001). It should have a smooth and viscous texture (Tamime and Robinson, 2000).

The physical attributes of yogurt including the lack of visual whey separation and perceived viscosity are the crucial aspects of the quality and overall sensory consumer acceptance of yogurt. It is a growing area of interest due to its convenience, portability, and ability to deliver all of the health and nutritional benefits of regular yogurt (Farnworth, 2008).

Popularity of yogurt products continues to grow due to its health benefits. Today, there are many yogurt products sold in the market such as set-yogurt, yogurt drink, frozen yogurt and stirred yogurt (Matitila-Sandholm and Saarela, 2003).

2.2 Yogurt drink

Drinking yogurt is a type of stirred yogurt that has low viscosity, normally consumed as a refreshing drink and popular in many countries such as Malaysia, Thailand, Vietnam, Japan and China (Tamime and Robinson, 2000). It is usually flavoured with fruit juice or synthetic flavouring and colouring compound. Depending on the process employed, three different types of product may be marketed, it includes short shelf life (3 weeks under refrigeration), medium shelf life (several weeks under refrigeration) and long shelf life (several months at room temperature). These grouping depend on the handling coagulum after fermentation and, in particular, on the extent of any treatment (Richard, 2002). According to Kiani *et al.* (2010), commercial processes for the manufacture of drinking yogurt could be classified into the following types:

i. Homogenise stirred yogurt, cool and package; shelf life 2-3 weeks at 5°C.
ii. Homogenise stirred yogurt, pasteurised (low temperature) and aseptically package; shelf life 1-2 months at 5°C.
iii. Homogenise stirred yogurt, UHT and aseptically package; shelf life several months at ambient temperature.

Smith and Hui (2004) also reported that the shelf life expectation from commercial yogurt approximately three weeks from the date of manufacture in the condition of temperature during distribution and retail marketing channels that does not exceed 7°C. Lactic acid and some other metabolites produced by the fermentation process protect yogurt from most gram-negative psychotropic organisms. However, most yeasts and moulds may grow, which are highly tolerant of low pH and can grow at refrigeration temperature. Thus, aggressive sanitation procedures related to equipment, ingredients, and the plant environment should be emphasized to control the yeast contamination in yogurt (Smith and Hui, 2004).

Generally, milk alone is normally used in the production of drinking yogurt but other food additives may be added to the milk such as fruits, malt extract, sweet

cream buttermilk and cereal product (Kiani *et al.*, 2010). The addition of fruits into the yogurt may enhance the flavour as well as adding some nutritional benefit of the fruits to the yogurt (Farnworth, 2008). Milk base and any miscellaneous additives are normally fermented with a starter culture, but a wide range of mixed cultures has been used. Slow acidification of milk by *Lb. bulgaricus* and *S. Thermophilus* for more than 48 and 140 hours, respectively, helped to minimise the precipitation of protein in the product (Kiani *et al.*, 2010).

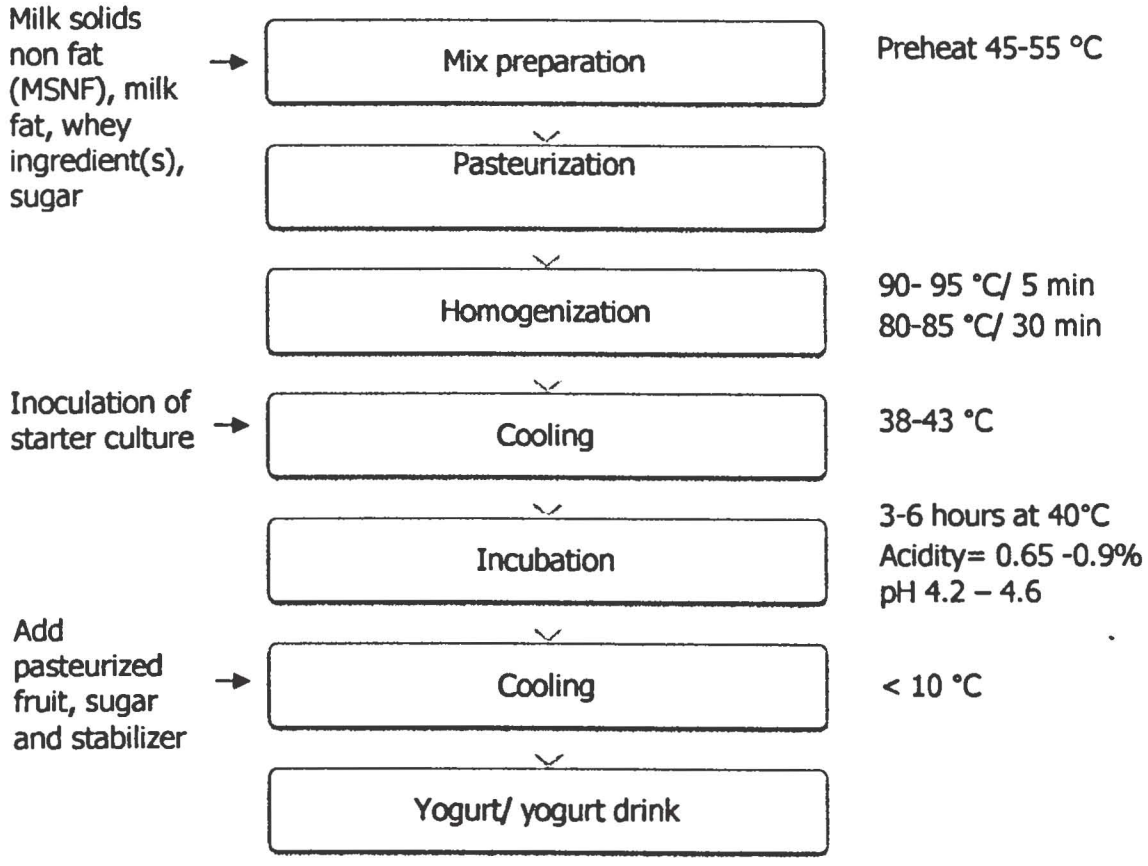

Figure 2.1: Basic process of yogurt drink.

Source: Hui (2007)

Lee and Lucey (2010) reported that the main processing of yogurt drink includes the standardization of milk, homogenization, milk heat treatment, incubation/fermentation, cooling and storage as shown in Figure 2.1. The mixing of all the ingredients is done after standardization of the milk and being pasteurized for 90-95°C in 5 minutes or 80-85°C in 30 minutes. It is then being homogenized and cooling at 38-43°C to inoculate the starter culture. After the inoculation is the process of incubation for 3-6 hours at 40°C to reach the acidity of 0.65 to 0.9% and pH of 4.2-4.6. It is then being cooled below the 10°C and other fruit, sugar, water and stabilizer are being added. The yogurt drink may be and shall be pasteurized or ultra-pasteurized prior to the addition of the bacterial culture in which flavouring may be added after pasteurization or ultra-pasteurization. To extend the shelf life of the food, yogurt may be heat-treated after culturing is completed, to destroy viable microorganisms (Hui *et al.*, 2005).

According to Kiani *et al.* (2010), whey separation may be a problem during the manufacture of drinking yogurt and is necessary to incorporate a stabiliser into the milk base. The particles of yogurt drink are separated and free to sediment under gravity, causing massive loss of stability which becomes more severe as the extent of dilution is increased. This separation known as "wheying off" or "syneresis" that leads to separation into a casein-rich lower layer and an upper layer of clear "serum", which can often occupy more than half of the total volume (Kiani *et al.*, 2010). Syneresis is defined as the shrinkage of gel and this occurs concomitantly with expulsion of liquid or whey separation and is related to instability of the gel network resulting in the loss of the ability to entrap all the serum phase (Renata *et al.*, 2006). Janhoj *et al.* (2008) reported that syneresis in drinking yogurt was minimised by the addition of high methoxy (HM) pectin. In dilute acidified milk systems, HM pectin stabilize the milk proteins to produce products without sedimentation and whey separation, thus ensures a smooth mouth feel without "sandiness" (Chandan *et al.*, 2006). HM pectin adsorbs onto the casein micelles as the result of electrostatic interaction and the mechanism of stabilization of drinking yogurt has been proposed to involve adsorption of pectin

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