UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT OF PORTABLE LACTATE STORAGE BY APPLYING PELTIER MODULE AS ENERGY CONVERTER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning Systems) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning System) with Honours. The member of the supervisory is as follow:

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(TS. Mohd. Farid Bin Ismail)

ABSTRAK

Portable Lactate Storage merupakan satu tempat penyimpanan yang khusus direka dan dibentuk bagi penyimpanan susu ibu. Kini terdapat juga beberapa jenama atau bekas penyimpanan yang telah berada dipasaran. Namun begitu, produk ini memiliki beberapa ciri tambahan yang mana ia dapat mengekalkan suhu maksima susu ibu sehingga lima darjah Celsius dalam masa lapan jam. Beberapa eksperimen telah dijalankan bersama kajian soal selidik bagi mengetahui kehendak pengguna dan memastikan produk yang dihasilkan ini dapat memelihara kesegaran susu ibu tersebut dalam tempoh lapan jam minima. Melalui pembentukkan dan eksperimen pertama yang dilaksanakan, Produk ini menggunakan *expanded polystyrene* dan kerajang aluminium sebagai struktur utama dan bahan penebat haba. Kedua-dua bahan ini adalah ideal bagi pembentukan tempat penyimpanan susu ibu kerana ia ringan serta dapat tahan dari kehilangan suhu yang banyak dalam sesuatu tempoh. Peranti utama yang digunakan bagi medium penyejukkan adalah Peltier. Peltier ini disambungkan kepada dimeterai asid plumbum boleh dicas semula (bateri 12V). Permukaan yang sejuk dihalakan kedalam produk manakala permukaan yang mengeluarkan haba panas dihalakan keluar produk. Dengan menggunakan pengekodan yang telah disetkan di Arduino Uno, produk ini hanya akan beroperasi apabila suhu di dalam Portable Lactate Storage ini melebihi dari lima darjah Celsius. Jika suhu yang dicapai kurang dari lima darjah Celsius maka, sistem di dalam produk ini akan dinyah aktifkan kecuali kipas utama. Kipas utama tidak dinyah aktifkan bagi tujuan mengelakkan proses pemeluapan daripada berlaku. Hasilnya, produk ini dapat menjimatkan penggunaan bateri bagi jangka masa yang lama dan suhu dapat dikekalkan bagi menjaga kesegaran susu ibu tersebut.

ABSTRACT

Portable Lactate Storage is a storage specifically designed and developed to store breastmilk. Now there are also some brands or former containers that have been marketed. However, this product has some additional features that can maintain the maximum breast milk up to five degrees Celsius within eight hours. Some experiments have been conducted with a questionnaire to find out consumers' needs and ensure that these products are able to maintain the breast milk freshness within a minimum of eight hours. Through the first creation and experimentation, the product uses expanded polystyrene and foil aluminium as the main structure and heat insulation material. Both of these materials are ideal for the formation of breast milk storage sites because they are light and able to withstand from the loss of large amounts of temperature at a time. The main device used for cooling is Peltier. This Peltier is connected to a rechargeable lead acid (12V battery). Cool surfaces are directed towards the product while the hot surface is directed out of the product. Using the coding set of Arduino Uno, this product will only operate if the temperature inside the Portable Lactate Storage exceeds 5 degrees Celsius. If the temperatures are less than five degrees Celsius then the system in this product will be deactivated except the main fan. The main fan is not disabled for the purpose of avoiding process condensation from occurring. As a result, this product can save battery life for long periods and the temperature can be maintained to keep the breast milk fresh.

DEDICATION

This paper is dedicated to my beloved parents, my supervisor, respected lecturers and my friends.

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Firstly, I would like to thankful to Allah SWT as He gave me the chance to finish this task successfully. Thanks to both of my beloved parents, Mr. Haji Abdul Rahman Bin Balapan and Mrs. Naziran Binti Biran because they are the ones that are funding this project and keep pray for my success. They also provide me with moral motivation that I need during hard times within completing this task. Next, I would like to thank my respected supervisor Mr. TS. Mohd Farid Bin Ismail as he has given me knowledge on how to write a good research paper and how to defend this title. He also gave me a lots of positive thought. Other than that, not forgetting to my special friends, Mr.Ghazali Bin Ismail who always support and help me a lot beside lead me to done this task with all my effort. I also would like to thank to Mrs. Raidah Rauhah Binti Ahmad Saifulzaman who always keep me in the track and support me all the time.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

˚C	-	Degree Celsius
<	-	Less than
A	-	Ampere
a.m.	-	Morning
AC	-	Alternating Current
BH	-	Berita Harian
cm	-	Centimetre
CO	-	Change Over
COP	-	Coefficient of Performance
DC	-	Direct Current
DT	-	Double-throw
GDP	-	Gross Domestic Product
I_{max}	-	Maximum current
K	-	Potassium
K	-	Kelvin
k	-	Thermal conductivity
kcal	-	Kilocalorie
LED	-	Light Emitting Diodes
m	-	meter
mg	-	milligram
ml	-	milliliter
MWFCD	-	Women, Family and Community Statistics
NC	-	Normally Closed Contact
NO	-	Normally Open Contact
Oz.	-	Ounces
p.m.	-	Evening
PDAs	-	Personal Digital Assistance
PE	-	Polyethylene
PEVA	-	Polyethylene Vinyl Acetate
SLA	-	Sealed Lead Acid

V	-	Volt
W	-	Watt
WHO	-	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Introduction

After women finished their study in college or university, besides getting marriage, first thing that come across their mind must be finding a job for herself. Nowadays, women are free to work according their wishes because they realise they do not have to depending on others to survive and being successful. However, when they are getting married and delivered baby, they do need to give breastfeeding at the early stage or childhood frequently. It is a big responsibility that they have to do. Hence, without make the current job as a problem or barrier, they will send their baby to the baby sitter in order to take care the baby during the working hour. Sometimes, mothers need to pump their milk during working time and keep it in bottles and stores them in the freezer so that it can sustain the milks' freshness. After that, the milk will be given to baby sitter to feed their baby.

1.2 Problem Statement

As was pointed out in the introduction to this paper, mothers will transfer the milk from the offices' freezer to baby sitter freezers' or their own homes' freezer. The journey from the office to another place could take time due to traffic jam, cars' problem and of course because of the long distance itself. One possible implication of this is the milk cannot be use anymore because it is already expired or stale due to the exist long time in hot condition. These findings have significant implications for the

understanding of how the milk must be store in similar condition. Hence, the solution to this problem is that a system needs to be developed. This system should be portable storage for long period travel at suitable condition.

1.3 Aim Objective

The objectives of this project are:

a) To develop a portable lactate storage device for a long travelling period without damaging the lactate or shorten the lifetime.
b) To fabricate and redesign the portable lactate storage device by applying Peltier module as energy converter from electric to heat energy.

1.4 Project Scope

There are several limitations in this project:

a) The size of this Portable Storage Lactate must at least can fit for six units of five ounces (5 oz.).
b) The temperature of Portable Lactate Storage must be reached the maximum at 5˚C.
c) Portable Lactate Storage can keep the milks' freshness for at least eight hours.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Many people try hard to think on how to create a storage that can store milk for a long period of time. Based on previous chapter, mothers' milk is easily to stale and cannot be use anymore when it is not in ideal temperature. By knowing all the nutrients and vitamin that contain in mothers' milk, for sure mother will be so happy and excited to feed their baby in hope their baby will grow up healthy. At the beginning of six months of baby, breastfeeding is very important because at that stage, their anti-body is starting to develop to against any infection and boost more anti-body. There is no any excuse to avoid from feed their baby because mother will pump their milk for her baby. Other than that, by giving breastfeeding it will make a strong bond between mother and baby. As a consequence, mothers will try hard to looking the best lactate storage in order to keep their milk fresh during the long journey.

Everyone has their own desired criteria that makes that particular storage can be buy for them. As well as this project, Portable Lactate Storage will get some feedback from customer or consumer by doing survey. In that survey, consumers will be asked and consider several aspects such as its capacity, quiet operation, light-easy to carry, designs, affordable with low price and multi-function (cooler and warmer). If in overseas, warmer option might be necessary for mother in order to melting or makes their milks warm once it is out from the fridge but, in Malaysia, the surrounding

temperature are good enough to makes the lactate warm or suitable to feed. They do not need to wait for a long time for getting the milks melt if it is in frozen condition.

The smallest fridge already in market and the uses of those small fridge are for keeping their beverage and food. Those small fridges are come out with cable which it is need to be plug in into the socket whether in building or in the car in order to enable it function. For example, in other country the Uber Appliance Uber Kühl Mini Fridge is very similar to the Uber Chill Retro Mini Fridge as shown in the Figure 2.1. It utilizes the same thermo electric system, comes with the portable plug, has the ability to cool and warm and it has the same capacity 4 Litters. The beauty of the Uber Kühl comes in its super cute colours, it comes in three different colours, Uber Pink, Uber Pearl White and Baby blue. This is the perfect fridge for a nursery. Any nursing mother that is looking for a small quite portable fridge to store breast milk should be looking at this cute little unit. Highly recommended by all moms check it out. ("The Best Mini Fridge: Top 5 Mini Fridges," n.d.). However, the Portable Lactate Storage will come out with many similarities but there is some variant is without using a plug and exist with freezer instead of having refrigerator only.

Figure 2.1: Uber Appliance UB-XL1-RED Chill 12 Can Retro Personal Mini Fridge

2.2 Lactate

Breast milk refers to the milk produced by the mother's mammary glands located in the breast as shown in Figure 2.2. The breast is a gland consisting primarily of connective and fatty tissues that support and protect the milk producing areas of the breast. The milk is produced in small clusters of cells called alveoli. The milk travels down ducts to the nipples("How Breast Milk is Produced, 2008"). Milk is exclusively for use as a baby food. Milk is seen as an early food in the form of fluid that has a good nutritional value compared to animal products or formula milk as it is easily digested well given to children aged between 6 months to 2 years. The World Health Organization (WHO) recommends breastfeeding exclusively for babies who are six months of age of birth (Library & Accessed, 2018). This means no additional supplements for new-borns until they reach age six months after birth. Formula milk, fresh milk from animals and even mineral water and drinking water are enough to cause the baby to develop growth problems, illness complications and redness or allergy signs can occur.

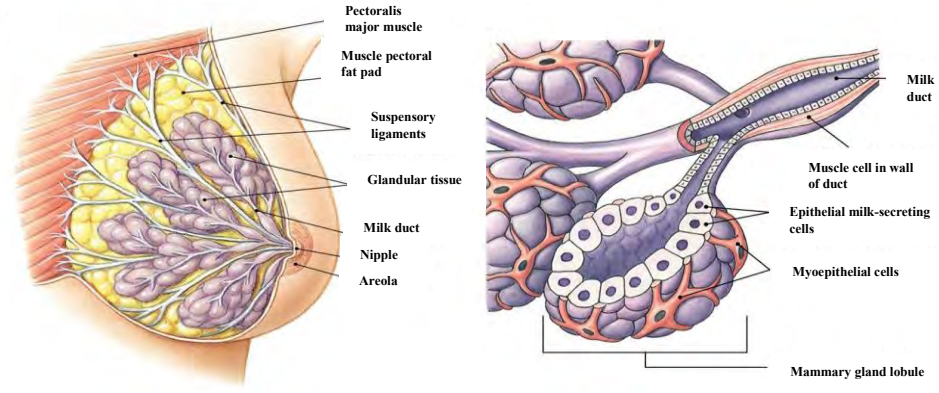

Figure 2.2: Mammary Glands

2.2.1 Composition of Lactate

Sometimes mothers will think to feed their baby with formula milk which it is the easiest way to avoid her own milk stale when they are in long journey and do not have a good lactate storage. However, despite formula milk is easy to handle and give, there are many disadvantages than advantages. For example, from Table 2.1 it can be seen that amount of protein in formula milk has much more than in breastmilk but, it will affect to baby's digestion system which it will not completely digested. Other than that, mineral such as iron has lower amount than in breastmilk. However, the minerals in breast milk are more totally absorbed by the baby. In formula-fed babies, the unabsorbed portions of minerals can alter the balance of microbes within the intestine, which gives destructive microscopic organisms a chance to develop. This can be one reason why bottle-fed babies for the most part have harder and more odorous stools than breastfed babies.

Table 2.1: Comparison of nutrition between breastmilk with formula milk

Nutrients	Breastmilk	Formula milk
Protein, g	1.3	2.0
Carbohydrate, g	7.2	9.4
Iron	0.07	0.87
Fat, g	4.1	4.0
Vitamin C, mg	4.0	20.1
Calcium, mg	34	94
Chloride, mg	42	107.2
Magnesium, mg	3	10
Potassium, mg	58	107.2

2.2.2 Stale Mother's Milk

Mother milk composition is different for each individual. For example, this difference can be distinguished by mature maturity and premature birth. Mother's milk has colostrum, foremilk and hindmilk. Colostrum is a breast milk produced after the birth of the new born and lasts for 2-4 days. Colostrum is very important part of breast milk and lays down the immune system and confers growth factors and other protective factors for the young ones in mammals (Thapa, 2005). Foremilk is the milk stored on the storage channel and will go out early during the feeding stage. Foremilk is produced with so much to eliminate the baby's thirst. Hindmilk will come out after the foremilk ends. Currently hindmilk is very rich in essential fat and vitamins.

Among the things that are often done are many mothers who pump their milk and keep it in the freezer. Then dilute the milk in a double boiled manner. As a result, breast milk will be destroyed by all its nutrients if the milk is boiled because of the sudden changes in temperature. It should, after pumping the milk, the milk should be left for a while at room temperature then stored in the bottom refrigerator and transferred to the freezer. To warm the milk, the milk needs to be removed from the refrigerator and left for a while or passed under the tap water until it melts. Then it is heated by soaking the bottle containing the milk in hot water. In addition, many also shake milk after heated. When it is shaken, the milk protein molecule will be broken and broken. So the way is that the milk needs to be shaken very slowly just as all the elements contained can be mixed well.