



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND FABRICATION OF WORKING
PROTOTYPE CHILLER AND WARMER STORAGE
FOR BREAST MILK USING PELTIER EFFECT**

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

by

KHO SIEW WEN

B071511082

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

Signature:

Supervisor : TS. LUQMAN HAKIM BIN HAMZAH

ABSTRAK

Tajuk projek ini adalah 'Reka Bentuk dan Fabrikasi Penyejuk dan Penyimpanan Panas untuk Susu Ibu dengan Menggunakan Kesan Peltier'. Ramai ibu-ibu yakin tentang kepentingan penyusuan susu ibu. Walau bagaimanapun, penyusuan susu ibu secara terus tidak selalu mungkin. Tambahan pula, mereka menghadapi masalah penyimpanan susu ibu ketika perjalanan atau memandu. Oleh itu, mereka memerlukan simpanan yang mudah alih untuk menyimpan, menyejukkan dan memanaskan susu ibu. Objektif projek ini adalah untuk merekabentuk penyejuk dan penyimpanan panas untuk susu ibu. Berdasarkan kaedah reka bentuk keseluruhan melalui kaji selidik, pemilihan konsep, Spesifikasi Reka Bentuk Produk dan House of Quality, prototaip penyimpanan susu ibu telah direka dengan menggunakan kesan Peltier yang boleh pemanasan dan penyejukan. Melalui ujian eksperimen pada prototaip, terbukti prototaip ini mampu menyejukkan dan memanaskan susu ibu. Ia boleh berfungsi dengan baik untuk membantu ibu mengekalkan kualiti susu ibu.

ABSTRACT

The title of this project is 'Design and Fabricate a Working Prototype Chiller and Warmer Storage for Breast Milk by using Peltier Effect'. Many mothers convinced of the importance of breast feeding currently in this time. However, direct breast feeding is not always possible. Furthermore, they get even more complicated when travelling or driving, especially the breast milk storage problem. Thus, they need a portable storage to store, cool and warm the expressed breast milk. The objective of this project is to design and fabricate a working prototype chiller and warmer storage for breast milk. Based on total design method through survey, concept selection, Product Design Specification (PDS) and House of Quality (HOQ), the prototype of a breast milk storage have done designed and fabricated by using the Peltier effect which can perform heating and cooling both. Through experimental test on the prototype, it was proven that the prototype is capable to chill and heat the expressed breast milk. It could perform well in assisting mother maintaining the quality of the breast feed milk.

DEDICATION

This dissertation is dedicated to all my family members and friends. It has always been my parents who nurture me with affection, trust and moral support whenever any challenges get tougher. Their unconditional love reminds me that I could not easily disappoint them and even try harder. All my fellow friends are deserved to be partners in my success of the project especially my housemates. They have provided me a lot of miscellaneous aids and words of encouragement which make me to think in a positive manner when things go wrong. I also want to dedicate this dissertation to my supervisor who is willing to teach and assist me in any part of the project which I had trouble with.

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LIST OF ABBREVIATIONS

PDS	Product Design Specification
HOQ	House of Quality
QFD	Quality Functional Deployment

CHAPTER 1

INTRODUCTION

1.1 Background

Many mothers find it convenient to collect their breast milk and store it for use at a later time. Breastfeed is the best way to provide an infant with breast milk, however, this may not always be possible due to various reasons, such as the case for mothers who return to work, mother who are separated from their infant, during travelling and so on. Expressing breast milk enables mothers to feed their baby with the breast milk which provides optimal nutrition for infant.

It is important that stored correctly of the expressed breast milk to prevent affect its nutrients and biological activity characteristics. Hence, it is an unavoidable need to store expressed breast milk for a limited period of time. Furthermore, the storage temperatures and the length of storage time of breast milk can be stored vary, depending on whether the breast milk is freshly expressed or has been refrigerated or reheated.

Expressed breast milk stored in the freezer or refrigerator is usually defrosted and warmed before it is accepted by the infant. It is important to take precautions to ensure the temperature of expressed breast milk does not become too high for the infant or lose its beneficial properties during the warming process. Expressed breast milk should be warmed up to body temperature before its feed, especially in premature infants. When breast milk is overheated, the feeding tolerance will become greater and fat absorption may be reduced by about a third. However, breast milk is sensitive to the temperature. In addition, some nutrients and bioactive properties of breast milk may be affected by storage conditions. Thus, it becomes

vital to ensure the breast milk does not reach critical temperatures which might cause denaturation of these bioactive proteins and lead to their inactivation during the heating process.

The breast milk storage available in market have been designed in various size but it limited for cooling. So, in this project focuses on designing and fabricates a working prototype chiller and warmer storage for breast milk by using Peltier effect which can cooling and warming the breast milk in the same time. Beside that it is a useful breast milk storage especially for the family with baby during a road trip.

1.2 Problem Statement

An online questionnaire was created and there are 76 respondents involved in this online questionnaire. The majority (68.4%) of the respondents chose breast feeding as the feeding methods of their infant or child in the household. It shown that many mothers convinced of the importance of breast feeding currently in this time. However, direct breast feeding is not always possible. When the infant cannot breastfeed directly, it may be necessary to express breast milk to provide all the milk that the infant needs. There are 60.5% of the respondents said that they will pump breast milk during driving or travelling to express the breast milk.

However, 33.3% of the respondents indicated that they are concerning on breast milk spoiled due to storage and 25% of the respondents indicated that they are concerning on spillage breast milk. 71.6% of respondents said that it would be helpful if a portable chiller exist allowing them to store breast milk during driving or travelling.

In addition, families with breast-feeding babies get even more complicated when travelling or driving, especially they need to face the breast milk storage problem. 68.4% of respondents represented that they used warm water to defrost or warm expressed breast milk

during travelling or driving. Of all the respondents, 71.6% reported that they had encountered the problem of warming breast milk or finding warm water for formula milk during travelling or driving. 61.8% of respondents said that it would be helpful if a portable warmer exist allowing them to warm breast milk or finding warm water for formula milk during driving or travelling.

Thus, they need a portable storage which can store, cool and warm the expressed breast milk for use during travelling or driving. However, the product in the market does not follow those people requirement. From the survey, 90.8% of the respondents indicated that it encourage them to breastfeed more if available of a product which can function as a chiller and warmer for breast milk. The response of respondents to the product from survey result as shown in Figure 1.1.

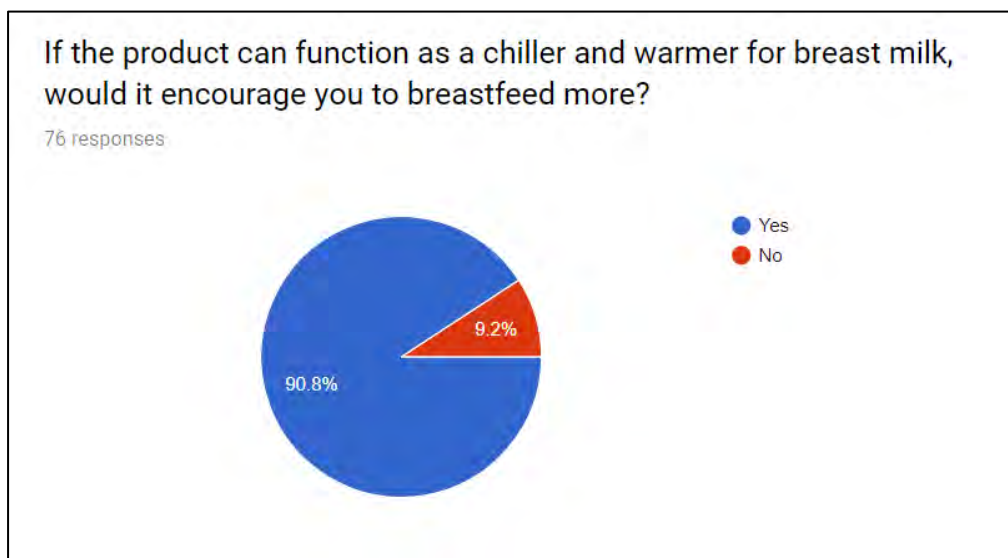


Figure 1.1: The response of respondents to the product from survey result

1.3 Objectives

The objective of this project is to design and fabricate a working prototype chiller and warmer storage for breast milk.

1.4 Scope

There are three properties will be effect the breast milk stability and composition which are storage time, container type and storage temperature. The scope of this research will be focus primarily on the storage temperature for breast milk. Hence, data collection will be limited to storage temperature of breast milk. The suitable temperature will be selected which is suitable and function properly to chill and to warm the breast milk.

Furthermore, the working prototype chiller and warmer storage for breast milk will be design by using Peltier effect. Peltier effect is one of the type of thermoelectric effect and it states that when a voltage flows through the junctions of two dissimilar electrical conductors, heat is deposited from one junction and removed at another junction. Peltier Coolers have various important advantages. It can be incorporated into other devices or used by itself and can rapidly switch between high and low temperatures.

CHAPTER 2

LITERATURE REVIEW

2.1 Breast Milk

Breast milk is known as the perfect and natural food for new-born infants. It is a secretion of changes in the composition of the mammary gland. Breast milk supplies all the necessary nutrients for the growing infants (Sari et al., 2012). It is uniquely superior for infant feeding due to its species specific. Besides that, colostrum, transitional milk and mature milk are the breast milk which collected from mother at 3, 8 and 30 days after giving birth. The colostrum differs from hind milk and strikingly different from transitional and mature milk. Colostrum is the first secretion from mother after giving birth (Anatolitou, 2012).

In 2003, the World Health Organisation (WHO) recommended that infants should exclusively breast feeding for up to six months of age and continue breast feeding thereafter combine with suitably nutritious complementary foods to maximize health benefits of infants (World Health Organisation (WHO) 2003).

Mothers who are breast feeding baby normally produce between 19 to 30 ounces of milk a day. Infants who between one and six months of age normally drink an average of 19 to 30 ounces each day (Daly, Owens, & Hartmann, 1993). An average size “meal” for an infant is between 3 to 5 ounces of breast milk.

When the infant cannot breastfeed directly, it may be necessary to express breast milk for a long period of time to provide all the milk that the infant needs (Kent, Prime, & Garbin, 2011).

2.2 Important of breast feed

2.2.1 Benefits for the infants

Breast milk is species-specific and all substitute feeding preparations significantly different, making it uniquely superior for infant feeding. (Weiss, 2005). The nutritional content and functional properties of breast milk are unique. Breast milk has been cited as reasons for preferring breast milk in the feeding of low birthweight and normal term infants due to its high bioavailability of nutrients, its optimal nutrient concentrations and pattern, and its immunological components (Garza, Johnson, Harrist, & Nichols, 1982).

Study of Hanna stated that breast milk is considered an ideal nutrient for the normal term and premature term infants. It benefits host's defences, digestion, and absorption of nutrients, gastrointestinal function and neuro-development of infants. Feeding breast milk protects against infection and inflammation, and colostrum is enriched in immune factors that help to ensure infant survival (Ballard & Morrow, 2013).

Breastfeeding is associated with many benefits such as fewer gastrointestinal, respiratory, aural and urinary tract infections and fewer atopic illnesses. It has been consistently shown to reduce mortality among premature infants (Begley, Gallagher, Carroll, & Millar, n.d.).

Breast milk provides infants with defensive factors against many diseases. According to report of Lorico, Perez, & Makati, infants who are breast feed appear to be less susceptible to certain infections than formula feed infants (Lorico et al., 2012). This statement support by Ogundele, who stated that breast milk contains various

immune-active substances which protect the infant against a wide range of infectious and other diseases.

Reduced antioxidant capacity in premature infants is often exposed to oxidant stress due to mechanical ventilation, oxygen, intravenous nutrition, infection and blood transfusions. Imbalance between antioxidant capacity and oxidative stress caused the infant diseases, such as chronic lung disease, retinopathy of prematurity, necrotising enterocolitis, and intraventricular-periventricular haemorrhage (Hanna et al., 2004).

For premature infant, breast milk is easier to digest compare with formula. The concentrations of scavengers of free radicals of breast milk is higher than cow's milk (Hanna et al., 2004). The proteins in the formula are made from cow's milk, and infants' stomachs need more time to digesting them (Katherine R. Shealy; & RLC Ruowei Li, 2005).

2.2.2 Benefits for the mother

Mother attains considerable benefits when breastfeeding. The benefits include reduced postpartum bleeding and faster uterine involution attributable to increase oxytocin concentrations. It also increased child spacing attributable to lactation amenorrhea and reduced menstrual blood loss (Weiss, 2005).

Furthermore, breastfeed helped mother to return their weight before pregnancy earlier. It possibly decreased risk of hip fractures and osteoporosis in the postmenopausal period (Weiss, 2005). Mbwana also reported that mothers who practiced breastfeeding may achieve pre-pregnancy weight faster. In the long term, breastfeeding has been reported to lower the risk of iron deficiency anaemia (Mbwana, 2012).