



UNIVERSITI PUTRA MALAYSIA

***IN VITRO GLYCAEMIC INDEX OF SELECTED CANNED FOODS
IN THE LOCAL MARKET***

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***IN VITRO* GLYCAEMIC INDEX OF SELECTED CANNED FOODS**

IN THE LOCAL MARKET

BY

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A project submitted as a partial fulfilment of the requirement for the degree of Bachelor of Science in Nutrition and Community Health form the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

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ABSTRACT

***IN VITRO* GLYCAEMIC INDEX OF SELECTED CANNED FOODS IN THE LOCAL MARKET**

Nur Khuraishah Binti Sulung

Health issues on food intake with a high glycaemic index become alarming these days as it contributes to non-communicable diseases. The high consumption of canned food has grabbed the attention of healthcare professionals because of its nutrient composition as processed foods that include a high amount of sugar, fat, carbohydrate, sodium and others that negatively affect health. Based on observation of research surveys, the determination of *in vitro* glycaemic index is still lacking, and most researchers studied starchy-rich foods but limited on canned foods. Thus, this study determined the *in vitro* glycaemic index of the selected canned foods (fruits- lychee in heavy syrup (LHS), vegetables- sweet corn cream style (SCCS), pulses- baked beans in tomato sauce (BBTS), meat- beef curry with potatoes (BCWP) and poultry- chicken curry with potatoes (CCWP) and milk- sweetened creamer (SC)) in the local market. This study aims to provide data of glycaemic index for researchers and manufacturers as limited information is available on canned food products in the local market. Comparison of means among the analysed food samples was computed using ANOVA Tukey's test. Bivariate Pearson's correlation was used to determine the association in this study. The findings of this study on estimation of GI (eGI) among the selected canned foods were based on glucose as the reference food. The data obtained showed that canned SCCS and LHS had high eGI of 57.48 ± 0.41 and 57.39 ± 0.46 , respectively. The BCWP (41.66 ± 0.09) and SC (41.35 ± 0.10) had the lowest eGI among the analysed canned food. The findings also found no significant correlation between eGI and eGL ($r(18) = 0.430, p = 0.075$). All in all, the findings of this study may provide data on the estimation of GI values for the selected canned foods in the research field.

ABSTRAK

IN VITRO GLISEMIK INDEKS MAKANAN DALAM TIN YANG TERPILIH DI PASARAN TEMPATAN

Nur Khuraishah Binti Sulung

Masalah kesihatan berkaitan pengambilan makanan dengan indeks glisemik tinggi adalah membimbangkan pada hari ini kerana ia menyumbang kepada penyakit tidak berjangkit. Pengambilan makanan dalam tin yang tinggi telah menarik perhatian penjagaan kesihatan profesional kerana komposisi nutrien sebagai makanan yang diproses yang tinggi dengan gula, lemak, karbohidrat, garam natrium dan nutrien lain yang memberi kesan buruk kepada kesihatan. Berdasarkan pemerhatian terhadap tinjauan penyelidikan, penentuan *in vitro* glisemik indeks masih kurang, dan kebanyakan penyelidik mengkaji makanan tinggi dengan kanji tetapi terhad bagi makanan dalam tin. Oleh itu, kajian ini bertujuan untuk menentukan *in vitro* glisemik indeks makanan dalam tin terpilih (buah- buahan- laici dalam sirap pekat (LHS), sayur-sayuran- jagung manis ala krim (SCCS), kacang-kacangan- kacang panggang dalam sos tomato (BBTS), daging-kari daging dengan ubi kentang (BCWP), itik dan ayam- kari ayam dengan ubi kentang (CCWP) dan produk tenusu- krim manis (SC) di pasaran tempatan. Kajian ini juga bertujuan bagi menyediakan data glisemik indeks untuk penyelidik dan pengilang memandangkan maklumat glisemik indeks yang terhad bagi produk makanan dalam tin di pasaran tempatan. Perbandingan min antara sampel makanan dianalisis menggunakan ujian ANOVA *Tukey*. Bivariansi *Pearson* digunakan untuk menentukan hubungan dalam kajian ini. Dapatan kajian ini bagi anggaran GI antara makanan dalam tin terpilih ditentukan dengan menggunakan glukosa sebagai makanan rujukan. Data yang diperolehi menunjukkan bahawa SCCS dan LHS dalam tin mempunyai eGI yang tinggi dengan 57.48 ± 0.41 dan 57.39 ± 0.46 , masing-masing. BCWP (41.66 ± 0.09) dan SC (41.35 ± 0.10) mempunyai eGI terendah di antara makanan dalam tin yang dianalisis. Hasil kajian juga mendapati tiada hubungan yang signifikan antara eGI dan eGL ($r(18) = 0.430$, $p = 0.075$). Secara keseluruhan, penemuan kajian ini dapat menyediakan data mengenai anggaran nilai GI untuk makanan dalam tin terpilih bagi bidang penyelidikan.

CHAPTER 1

INTRODUCTION

1.1 Background

National Health Service (NHS) (2018) interpreted processed food as any food that, during processing, has been altered somehow. The modification involved freezing, canning, baking, and drying. Fuhrman (2018) described the characteristics of processed food as accessible, quick and efficient in terms of preparation as it required simple or no preparation at all. However, not all processed foods are unhealthy, mainly when the food contains high amounts of sodium, sugar and fat (National Health Service, 2018).

Canning is one of the processes that are underlying the processed food. Nicholas Appert invented canning in the late 18th century located in France (Vergara-Beladeras, 2016). The method of canning introduced around two centuries ago. It has been one of the primary food suppliers for a long time as a food preservative and cooling and freezing. Also, Shan (2016) reported that canned foods have been popular in the international market in the past century because it is easy to transport, convenient to eat, and has a long shelf life.

A study done by Velgera-Beladeras (2016) stated that conventional canning involves a process of food preservation in the food, which is stored in hermetically sealed containers and

heated to kill microorganisms. The use of heat is to destroy pathogenic and spoilable microorganisms. In order to prevent contamination of new microorganisms, the hermetic container was used. Continuing from the past, today, people seem to prefer consuming canned food due to its convenience to use, easy to assess and require less time consuming for food preparation.

The glycaemic index (GI) is defined “as the incremental area under the blood glucose response curve of a 50 g carbohydrate portion of a test food, is expressed as a percentage of the response to the same amount of carbohydrate from a standard food taken by the same subject” (Food and Agriculture Organization, 1998). GI is used to measure how much 50 g of carbohydrate from a specific food can increase blood glucose level (Jenkins et al., 2021). Jenkins et al. (1981) developed GI concepts at the University of Toronto to better regulate people with diabetes. GI values classified into three categories consisting of low GI (<55), medium GI (56-59) and high GI (>70) (International Standard ISO 26642:2010, 2010). Several studies found that diets with a high glycaemic response that associated with one of the factors that increase the level of blood glucose in the body corresponded with increased risk of non-communicable diseases, including obesity, type II diabetes, cardiovascular disease and certain types of cancer (Juanola-Falgarona et al., 2014; Greenwood et al., 2013; Howlett & Ashwell, 2008; Venn & Green, 2007; Brand-Miller & Holt, 2004; Augustin et al., 2002; Willett et al., 2002). Hence, as a consumer, it is essential to get accurate information about the food product consumed. The consumer has a right to be informed about the nutrition labelling on the food product, especially how to read the food labelling on the food product to help them choose healthier food products.

1.2 Problem Statement

Nutrients of processed food, including canned food, would be reduced as some nutrients may lose during the processing. Chepulis et al. (2018) stated that canned fruit and vegetables studied in their research showed that all of them consisted of apples, peaches, pears, plums, pineapple, beans, corn, and tomatoes reduced nutritional profile after processing when compared with the fresh form. Velgara-Balderas (2016) explained that among other factors, the retention of nutrients in canned foods varies based on the process, the product, and the nutrient. There were canned products for a long time in which mass amounts of vitamins have reduced during cooking, but other nutrients have remained high, such as protein and calcium.

Sugar is used widely in food production, which provides many functions for improving the properties of the food itself. According to Chong et al. (2019), processed food is the top one that has a high average sugar content (26.1%) compared to other comparative foods of local desserts, fruits snacks, beverages and cooked dishes which were 13.7%, 12.2%, 11.8%, 8.8%, 7.6% and 2.3%, respectively. Chepulis et al. (2018) demonstrated that canned fruit has 26-101 % higher sugar content than fresh fruit (per 100 g of product). High sugar content contributes to a detrimental effect on health as it is associated with non-communicable diseases (NCD) such as obesity, diabetes and cardiovascular diseases and affects the function of our body. For example, the impairments of neurological and cognitive deficits that underlie dementia development are due to excessive sugar intake (Roberts et al., 2012; Seetharaman, 2016; Seetharaman et al., 2015).

Other than that, health issues on food intake with a high glycaemic index become alarming these days as it contributes to non-communicable diseases. According to Chong et al. (2019), the proportion of carbohydrates in foods will affect the glycaemic index of foods. Foods with a higher proportion of carbohydrates are more likely to produce a higher GI than foods with lower carbohydrates. In the previous study, glucose resistance will remain a global problem with the increasing prevalence of metabolic syndrome and ageing (Zimmet, 2001). As elevated blood glucose concentrations and fluctuated blood glucose are risk factors for several diseases, the blood glucose response to foods remains a significant biomarker by which particular values drive the dietary consumption as part of preserving long-term health effects (Brownlee, 2001; Giugliano, 2008). Low glycaemic index is associated with slowing down starch digestion to prevent the spike in glucose in the bloodstream.

The glycaemic index claim is vital for the consumer as understanding GI concepts can help them make healthier food choices. Monro (2000) pointed out that the lack of guidelines for regulating eating preferences based on food benefits has been a long-standing problem. According to Chong et al. (2019), the Food Composition Database (FCD) of Malaysia, first published in 1997, has a limited database on nutrients and diets and does not provide a record of sugar. It is crucial to have an updated database, especially on macronutrients, total sugar, fibre, and other micronutrients, as one of the significant sources for researchers to obtain data related to food products in Malaysia.

Given these points, the determination of *in vitro* glycaemic index is still lacking, especially among canned and other processed food. Research surveys found that most researchers studied starchy rich foods (potatoes, bread, and rice) but limited canned foods. Moreover, the GI data of *in vitro* and *in vivo* of individual foods for canned foods were limited in the research field. Due to the reason of most canned food studied on mixed meals (canned chicken curry with white bread) instead of individual canned foods. Thus, this study determined the *in vitro* glycaemic index of selected canned foods within different categories (fruits, vegetables, pulses, meat and poultry and milk products) in the local market.

1.3 Significance of Study

The study determines the glycaemic index (GI) of the selected canned food through *in vitro* method. Based on the market survey done on canned foods in the local market, the nutrition claim and labelling of GI on food packages are limited among canned foods because GI labelling in Malaysia is not permitted. Apart from that, there is also limited labelling information to indicate the amount of sugar in canned food. The manufacturer should provide the information on added sugar (or other names) to show that the canned food has high sugar and provide the percentage of sugar content in the Nutrition Information Panel (NIP), especially when sugar is the main ingredient of canned food. This information is essential to inform consumers about the sugar content as it is one form of hidden sugar in canned food.

The implementation of GI labelling requires significant consumer knowledge and adoption of the industry to understand the concept of GI besides reducing misconceptions of the claim. Webster and Sollid (2018) argued that customers profoundly have negative thoughts against dietary carbohydrates as a source of weight gain. This study helps broaden the research on GI of canned food by providing GI information using an alternative *in vitro* method. This study also helps to strengthen the need of the industry to conduct nutrient analysis of their canned food. This approach can help to improve their product concerning health aspects and consumer needs and preferences. Thus, this study's findings can help update the Malaysian Food Composition Database (FCD) and helps to provide related data on canned food. The findings from this study can provide the guideline for the researcher to broaden their research finding in future.

1.4 Objective

1.4.1 General objective

To determine *in vitro* GI (eGI) and GL (eGL) among five categories (fruits, vegetables, pulses, meat and poultry and milk products) of canned food products available in the local market.

1.4.2 Specific objectives

1. To identify the labelling information of the canned food on total sugar content and macronutrients (carbohydrate, protein and fat) of the selected canned food based on a simple market survey.
2. To determine total available carbohydrate, total starch, fat and moisture content of the selected canned food using standard methodology.
3. To determine the estimated glycaemic index of the selected canned food products using *in vitro* glycaemic index method.
4. To determine the estimated glycaemic load of selected canned foods using the standard equation of glycaemic load.
5. To determine the correlation between estimated glycaemic index with estimated glycaemic load, analysed total available carbohydrate and fat content of the selected canned food.

1.5 Hypotheses

1. The value of the estimated glycaemic index of canned fruits is significantly higher compared to others selected canned foods.
2. The value of the estimated glycaemic load of canned fruits is significantly higher compared to others selected canned foods.
3. There is a correlation between the estimated glycaemic index with estimated glycaemic load, analysed total available carbohydrate and fat content of the selected canned foods.

CHAPTER 2

LITERATURE REVIEW

2.1 Glycaemic Index (GI) and Glycaemic Load (GL)

The glycaemic index (GI) is commonly associated with postprandial blood glucose response after ingested carbohydrate-rich food. A study demonstrated that postprandial glycaemic and insulinemic responses had known as the food glycaemic index (GI) (Bao et al., 2011; Livesey et al., 2008). In general, gradually digested carbohydrates are found effective for the dietary treatment of metabolic disorders such as diabetes and hyperlipidemia (Brand-Miller, 2003; Lehmann & Robin, 2007). According to Jenkins et al. (2021), high-glycaemic-index diets linked to increased cardiovascular disease and mortality risk compared to low-glycaemic-index diets. Moreover, a higher glycaemic index was associated with an increased risk of adverse consequences among individuals with a greater BMI. Low GI foods are associated with a positive health impact in lowering blood glucose levels. Brand-Miller & Jenkins (2007) revealed that the decreased occurrence and prevalence of heart disease, diabetes and some cancers were associated with long-term intake of low GI foods. Studies demonstrated that a low GI intake increases the physiological effects of insulin resistance and lowers it. These findings were previously supported by the Food and Agriculture Organization (1998) professional consultation on dietary carbohydrates as they advocate the significance of the GI concept.

Simple carbohydrates also contributed to dementia, mental illness, and cancer other than overweight and diabetes (Sommerfield et al., 2004; Kodi & Seaquist, 2008; Sanchez-Villegas et al., 2011; Gangwisch et al., 2015). There is substantial proof that heart disease is not enhanced only by saturated fat and high animal products but also by simple carbohydrates such as white rice, white bread, sugar, honey, maple syrup, and nectar agave (Halton et al., 2006; Barclay et al., 2008; Mirrahimi et al., 2012; Fan et al., 2012). A statistical meta-analysis of randomized controlled trials by Vinoy and colleagues (2017) found that those risk factors correlated with reducing glycaemic reaction. The study recommended regulating postprandial blood glucose, and insulin levels effectively consumed breakfast with low GI compared to high GI breakfast.

2.1.1 *In vivo* and *in vitro* of glycaemic index

Previously, many studies were conducted on *in vivo* techniques to determine the glucose response of the subject as *in vivo* is a gold standard method. Nevertheless, the *in vitro* procedures that are an alternative method of *in vivo* require consideration into many aspects that become quite challenging. Woolnough et al. (2008) highlighted that *in vivo* technique of glycaemic reaction assessment entails recruiting volunteers under the ethics committee's approval, the availability of medical staff for the extraction of blood, and clinical waste disposal procedures. Therefore, *in vivo* assessments can be considered complex, costly and time-consuming, referred to at least with those trials that evaluate a wide variety of foods and meals or labs that are not set up to conduct clinical research.

Ergo, there is a need to overcome the challenges and barriers *in vivo* to improve the method of determination GI to provide more rapid and reliable results. Argyri et al. (2016) concluded that reliable, easy and affordable *in vitro* instruments are required, while perhaps not replacing GI or GL measurement, would be an effective indicator of this benefit and can work as a percussive *in vivo* measurement screening technique. *In vitro* is the method that mimics the human digestion phase of oral, gastric and intestinal stages and the digestibility of carbohydrates measured after the human digestion phase (Fernandez-Garcia et al., 2009). In simple words, *in vitro* method is used to analyse the digestibility of carbohydrate-containing foods. However, Ren et al. (2016) and Foschia et al. (2015) found that not all research includes the oral process, leading to the limitation of the *in vitro* study. Argyri et al. (2016) concluded that *in vitro* is a valuable tool for screening several foods or meals before choosing a significant subset for further human glycaemic reaction assessments.

All techniques have their drawbacks, and this applies to *in vitro* methods. In terms of the instruments, a chemical reagent used and laboratory skills throughout the *in vitro* process need to consider when planning the *in vitro* studies. Argyri et al. (2016) also emphasised that the lack of a systematic, tested and commonly accepted *in vitro* technique is problematic, even though the wide variety of current approaches allows several tools to address different research objectives.

2.1.2 Factors that influence level of glycaemic response

Based on FAO/WHO (1998), food factors are one of the keys that influenced the food's glycaemic response. The food factors included the amount of carbohydrate or carbohydrate content in the food itself, besides, the nature of the monosaccharide components (glucose, fructose and galactose) and the nature of the starch components (amylose, amylopectin, starch-nutrient interaction and resistant starch). In addition, food processing or cooking also affects the glycaemic response based on the degree of starch gelatinization, size of the particle form of the food and cellular structure of the food. Other food components that influenced the glycaemic response included the level content of the fat and protein, dietary fibre, anti-nutrients and organic acids contained in the food.

Recently, based on the Glycaemic Index Foundation (2017), the structure of how refined or processed the carbohydrates are one of the most significant considerations deciding the GI of carbohydrate foods. The refined or processed fibre content of the food had removed. Thus, the changes in fibre content affect the capability of the carbohydrates to withstand digestive enzymes and is quickly metabolised and converted into glucose. The chemical structure of the carbohydrates also influenced the GI. According to FAO/WHO (1998), the nature of the monosaccharide component affects the GI and our body able to metabolise glucose efficiently. Another monosaccharide, such as fructose, could not be metabolised by the body, contributing to the low GI of fructose (GI = 23) (Glycaemic Index Foundation, 2017). The physical structure of the carbohydrates also influences GI. GIF (2017) proposed two factors of the physical structure that

affect the GI value, the size of the particle and the surface area of the food. As the particle size reduces, it gives the high possibility for the digestive enzymes to metabolise the food and increase the GI response. The GI value also increases with the increase of the surface area of the food.

Several studies found that food ingredients labelled on the food product packaging can influence the GI of the food. Commonly, carbohydrate is one of the nutrients that correspond to the food's value of the glycaemic index. Despite, other nutrients such as protein, fat, and fibre are also able to influence GI. In addition, according to Eleazu (2016), the time it takes for food to bypass the stomach and reach the gut is enhanced by fat. Fat consuming foods will influence the increase in blood sugar and produce a lower GI than equivalent foods without fat by slowing the rate at which dietary carbohydrates digested in the intestine. Dietary fibre described as a category of compounds found in plant foods that cannot fully break down by human digestive enzymes (British Foundation Association, 2015). Several studies found that the association between intake of fibre leads to lower GI. Based on a study of crossover clinical trials done by Lobos et al. (2017), both tested breakfast meals have similar macronutrients but differ in fibre content. Meals of low GI breakfast contained high fibre compared to the fibre content in high GI. The study's findings showed that in contrast with the group that consumed the high GI breakfast, participants that consumed the low GI breakfast reported a substantially lower postprandial response. The finding also supported by De Carvalho et al. (2017) that reported improving breakfast fibre content, either from diet or supplements, led to reduced postprandial glucose response.

Moreover, protein-rich diets improve insulin release, leading to a decrease in postprandial blood glucose (Eleazu, 2016). Some foods' natural protein content may be the reason why their

starches are not easily hydrolysing, which confers reduced GI on them. Thus, selecting food products should consider focusing on others' nutrient content instead of total sugar or carbohydrates content only.

2.1.3 Glycaemic load and glycaemic index

The concept of glycaemic load (GL) developed by Salmeron et al. (1997). According to Augustin et al. (2015), the GL expressed as the product of GI and the total available carbohydrate content in a given amount of food;

$$GL = GI \text{ available carbohydrate/given amount of food}$$

The value of available carbohydrates expressed in different types such as in gram (g) per serving, g per 100 g food, g per day's intake, and g per 1000 kJ or 1000 kcal (1 kcal = 4.184 kJ).

Food GL divides into low categories (≤ 10), medium (11–19) and high (≥ 20) (Venn & Green, 2007). Generally, GI provides information on the intensity of the conversion of carbohydrates into blood glucose, which does not include information on the quantity of carbohydrates and the effect of such diets on blood glucose levels (Manullang et al., 2020). Hence, glycaemic load (GL) may provide evidence on the extent of food intake on the blood glucose level. According to Eleazu (2016), GL refers to a product of GI and amount of carbohydrate consumed.

Therefore, GL also accounts for how much of the carbohydrate in a meal increases blood glucose level.

Similarly, Recommended Nutrient Intake (2017) stated the Glycaemic Load (GL) expressed as the product of the carbohydrate content of the food product by its GI divided by 100 ($GL = GI \times \text{carbohydrate content} / 100$). It used as a measure that incorporates the level of carbohydrate content and quality of dietary carbohydrates. Based on the meta-analysis findings of a randomized controlled trial study conducted by Toh et al. (2020), blood glucose responses reduced with breakfast of low GI and glycaemic load (GL) compared to high GI and GL breakfasts 60, 90 and 120 min. The findings supported by a past meta-analysis of RCTs documented low rates of exogenous glucose appearance and plasma glucose disappearance associated with higher content of slowly digestible starch with medium to low GI (Lehmann et al., 2007).

2.2 Canned Food

Canned food is one of the food groups of processed food. Under canned food, there are several types of canned food categorised based on its food groups. Featherstone (2015) described that the categories of canned food divide into four significant groups of canning of fruits, vegetables and pulses, canning of meat, fish and milk, canning of preserves and pickles and canning of composite products. Based on the major groups, canned foods are classified into several categories. Firstly, fruits, vegetables and pulses are grouped into vegetables, fruits, juices, fruit drinks and water, pulses and pasta and tomato products. Next, the canning fish, meat, and milk grouped into fish and seafood, meat and poultry, and milk products. Canning of preserves and pickles are classified into jams, jellies and related products, pickled products, mayonnaise and salad dressing products and packing dry or reduced water-activity products. Lastly, Featherstone (2015) stated that canning of composite products divided into soup, canned baby foods, and salads. In this study, out of 15 categories of canned food available in the market, only five categories of canned food will be selected. Based on the selected categories, six samples will choose for further analysis in this study.

All of the selected categories of canned food (fruits, vegetables, pulses, meat and poultry and milk products) based on Featherstone (2015) with a slight modification on the category of pulses and pasta. Canned fruits primarily consist of fruits with low pH (acidic), contributing to producing a commercially sterile product with a pasteurisation process. Several canned fruits contain a significant amount of added sugar that can affect the nutritional benefits, but for the

health/weight loss market, some recipes use less sugar, fruit juice, or water (Featherstone, 2015). Next, canned vegetables commonly include all types of vegetables, yet some vegetables should be canned based on a specific methodology to prevent food poisoning due to improper processing. In general, Featherstone (2015) explained that canned vegetables are all in the low-acid pH class, which ensures that they have to sterilise to be commercially sterile and stable at room temperature if they not acidified.

Furthermore, canned meat and poultry is a food group that is mainly high in protein. Meat refers to the edible flesh of animals such as chickens, pigs, and cows. There are several types of canned meat and poultry in soup, sauce, and curry-based. This category required strict hygiene care compared to other categories and production, processing and storage (Featherstone, 2015). Pulses are a food group that is part of the legume family whose pulses term refers to dried seed (Featherstone, 2015). Pulses are being used as canned food and commonly consist of canned beans, peas, chickpeas and lentils in the market. A combination of canned pulses and pasta in the similar category as those canned foods uses rehydrated dry pack ingredients (Featherstone, 2015). For this study, the category of pulses and pasta will be separate in this sample selection as the pulses food group will select. The selection considers the content of pulses high in protein, whereas the nutrients will be analysed on their correlation with the estimated glycaemic index in this *in vitro* study. Despite, the nutrient content of pasta food groups is quite common, mainly consisting of protein and carbohydrate (macronutrient) compared to pulses food group, which is more remarkable to determine if there is a significant correlation in this experimental study. Lastly, canned milk products consist of two types of milk products: condensed milk and evaporated milk

(Featherstone, 2015). Condensed milk is known as sweetened milk, while evaporated milk is unsweetened milk. Featherstone (2015) stated that the processing of both milk products differs in terms of the method to retain the milk. With a focus on preserving the evaporated milk, sterilization (intensive heat treatment) required, whereas sugar and reduction of water activity ($A_w \approx 0.78-0.82$) helps retain condensed milk.

The canned foods used in this study were purposely selected. Findings of the Household Expenditure Survey Report 2019 showed that 63.8% of Malaysian households spent on canned condensed milk (Department of Statistics Malaysia, 2020). Canned condensed milk was among the top tens of selected daily goods consumed by Malaysian households. The reports also discovered that percentage of expenditure on food and non-alcoholic beverages was higher among the Bottom 40% (B40) households group compared to the Middle 40% (M40) and Top 20% (T20) with 24.2%, 18.0% and 12.6%, respectively. Besides, canned foods are select, as Kapica and Weiss (2012) highlighted in their findings that the price of canned foods was lower than fresh or frozen foods. The results showed that the total cost per edible portion (TCEP) of canned green beans much lower compared to fresh green beans and frozen green beans with \$1.24 (RM4.99), \$1.96 (RM7.88) and \$2.95 (RM11.87), respectively. Hence, price is one factor contributing to the consumer's preferences on the consumption of canned food. The low cost of canned food makes it affordable for consumers, especially among low-income families.

Moreover, based on the current pandemic situation, frozen food and canned food consumption has increased substantially. For example in Germany and Denmark, some individuals substituted frozen food and canned food for their fresh food during the first lockdown period due to pandemic COVID-19 (Janssen et al., 2021). According to the study of Chenarides et al. (2021), respondents who indicated stocking pilling had a higher intake of dairy (5.6%), meat (8.8%), frozen food (9.0%), and canned food (9.7%) during the COVID-19 pandemic. This prevalence showed that people required canned foods at a particularly critical time as canned foods have a long shelf life.

2.2.1 Nutrients content in the canned food

Today, consumer trends seem to be shifting towards consuming convenience food such as processed food, ready-to-eat food and packaged food. These convenience foods are fit for them as the foods require minimal time of preparation and convenience to bring everywhere. However, health and nutrition are essential things to consider for consumers because they drive their food intake choices.

A finding from Featherstone (2015) stated that canned vegetables have high sodium content in the form of salt or brine which helps to maintain the flavour of the vegetables during canning. Besides, the study demonstrated that canned fruits commonly contained more significant amounts of added sugar. However, some canned fruits used fruit juice as a syrup for the canned fruits instead of added sugar. On the flip side, canned fruit with syrup commonly used sweeteners such as sucrose, invert sugar syrup, corn syrup, dextrose and high fructose corn syrup. The different names used to indicate that the canned fruits contained added sugar became health concerns. According to Featherstone (2015), refined syrup, a by-product of cane sugar, was added in canned beans in tomato sauce (baked beans) to darken the beans once the darker colour required. Based on the ingredients of the tomato sauce recipe for the canned beans in tomato sauce (baked beans), the sugar required was 6-10% higher than salt (1-2%), modified starch (1.5-2.5%) and vinegar (0.1-0.2%).

Moreover, sugar plays an essential role in canned condensed milk (sweetened). Specific type of sugar used for sweetened condensed milk which is sucrose, a highly refined cane sugar or

beet sugar (Featherstone, 2015). Other added sugar, such as dextrose or corn sugar, is not recommended. For instance, dextrose can decolourise and cause age thickening of the product at high-temperature storage due to its low level of sweetness. Besides, Featherstone (2015) emphasised that reducing water activity and adding sugar can help to preserve sweetened condensed milk. On top of it, a high concentration of sugar (approximately 42-45%) of the net weight can inhibit the spoilage of bacteria. In contrast, canned evaporated milk more depends on the use of salt. The addition of salt help increases the stability of heat, seeing that milk's ability to resist extreme heat treatment is crucial for evaporating milk.

Rehm et al. (2011) explained that dietary guidelines could meet by obtaining nutrients from the canned food. The nutrients can fulfil consumer needs regarding flavour, convenience, affordability, preparation skills, and ability to be stored, particularly for potassium, which tends to be more costly to incorporate into the diet. Albeit the canned food is good in nutrient content, the concern should highlight the sugar content available in the canned food. Correspondingly, based on the observation done in this study during the market surveys, common practice is to see canned fruits or other products that have sugar as their main ingredients. However, the GI claims and labelling of added sugar on canned food found still lacking.

Similarly, this applies to canned fruits or other canned products that have sugar with different names in their ingredients. The manufacturer or developer of the canned food should include the label of sugar content at least in the Nutrition Information Panel (NIP) of the product. Consumers are not aware of using different types of added sugar if the canned product lacks labelling information. This situation may cause misleading information for making healthy food choices.

2.3 Nutritional Analysis

2.3.1 Moisture content

Water is one of the significant components of food products. Removal of moisture content is vital in the food industry, such as the production of dehydrated food. Moisture removal rates and efficiency depend on the size and distribution of particles in a sample and the size and surface area of the sample after it is dried (Nielsen, 2017). After removing the moisture, the dry matter that remains is referred as total solids. The weight changes observed in oven drying methods assumed due to moisture loss. The process involves several methods such as oven drying, forced draft oven, vacuum oven, microwave analyser and infrared drying (Nielsen, 2017). Unlike others, infrared drying includes the penetration of heat into the material to be dried, as contrasted to heat conductivity and convection in conventional ovens. A study done by Özcan et al. (2020) found that the moisture content of infrared orange and lemon peels yield higher compared to microwave and oven-dried. However, cautious steps need to be taken to prevent the sample burn while drying.

The moisture content of analysed food samples in this study is determined based on the AOAC method that uses oven drying. The sample is heated under specified conditions in oven drying techniques, and the weight loss is utilised to determine the sample's moisture content. This process is a straightforward process to remove moisture in the analysed food samples and requires high temperatures at 105 °C. Similar to the infrared method, cautious steps should be taken to prevent samples from being over-dried due to being too long in the oven with a high temperature. Hence, the weight of samples while drying also needs to be monitored and measured until obtained consistent weight. All in all, oven drying is easy to use, albeit it takes time to dry a sample compared to other advanced methods and requires close monitoring.

2.3.2 Fat content

All nutrients are essential for our growth and development. However, each of them has its limitation of daily intake to prevent negative health consequences. Similarly, fat is also one of the crucial nutrients for our body. Based on Recommended Nutrient Intake (2017), fat also has structural purposes, such as supporting organs in place, insulating nerves, protecting the body from mechanical pressure, and insulating the body to maintain body heat and temperature. Fat has 9 kilocalories (kcal/g) high compared to carbohydrate and protein, and its recommended daily intake is 25% - 30% for Malaysians. Following carbohydrates, fat is the second most important source of energy. However, excess fat intake will be converted into glucose when there is limited fat storage in adipose tissue. Data from National Health and Morbidity Survey (NHMS) 2019 reported that 4 in 10 people in Malaysian had raised their total cholesterol level (Institute for Public Health, 2020).

Cholesterol is a form of fat that circulates in our bloodstream, but excess causes it to be stored and causes heart disease.

Several methods can use for the determination of fat content in food. The methods are divided into continuous, semi-continuous and discontinuous solvent extraction. Continuously define the sample exposed to boiling solvent for several hours, such as the Goldfish method. In contrast to semi-continuous, the solvent is exposed periodically, such as the Soxhlet method—the discontinuous methods such as Mojonnier and Chloroform-Methanol (Nielsen, 2017). The characteristic of solvent extraction used should evaporate rapidly with no residue left, non-flammable, low boiling point, and in both the liquid and vapour forms, it is non-flammable and harmless. The size of the particle also influences the extraction. The extraction process is efficient when samples are ground into small particles because it aids in the breakdown of fat–water emulsions, allowing fats to dissolve more readily in organic solvents and releasing fat from the tissues of foods (Nielsen, 2017).

This study determined fat content in the food samples analysed by using the Soxhlet method. Soxhlet extraction is a semi-continuous extraction (single solvent) method where the solvent accumulates around the sample in the extraction chamber and then drawn back to the boiling flask. The fat remains in the solvent due to low volatility, and the fat content is calculated by loss of weight or weight of fat removed. Mohideen et al. (2021) emphasised that Soxhlet extraction uses to extract volatile chemicals from raw materials. Lumanlan et al. (2021) stated that because the amount of water removed by pre-drying may reduce the gradient of water–oil transfer.

Besides, petroleum ether which consists primarily of pentane and hexane, is selected because it has a low boiling point (35-38 °C), more hydrophobic lipids, less expensive, less hygroscopic and less flammable (Nielsen, 2017). The past study stated that non-polar solvents are effective for oil extraction because the lack or absence of charges allows the solvent to pass into non-polar substances (Al-Hamamre et al., 2012). Lesten and Kingsley (2019) found that the greatest crude oil yield from petroleum ether extraction indicates that petroleum ether is more effective in extracting non-polar pumpkin seeds components than hexane and cyclohexane in the extraction of non-polar pumpkin seeds components from pumpkin seeds. Overall, hexane and petroleum ether are suitable as an extraction solvents. However, due to many expensive solvents, the Soxhlet method takes a long time and exposes the extracted lipids to high temperatures for extended periods.

2.3.3 Total available carbohydrate content

Carbohydrate is a major essential nutrient required as a fuel for our body. Carbohydrates are classified based on the degree of polymerisation and divided into sugars, oligosaccharides and polysaccharides (starch) (RNI, 2017). The recommendation of carbohydrate intake is 50%-65% for total daily energy intake (RNI, 2017). Carbohydrates play a vital role as preferred substrates for brain and red blood cells, and therefore, the IOM set an RDA of 130 grams per day for adults and children at least one year of age (Gourineni et al., 2017). In addition, carbohydrates are associated with glycaemic index values; whereas a low glycaemic index induces improve health as the glucose released slowly into the bloodstream.

In contrast to carbohydrates with high glycaemic index values, it can promote high blood glucose levels and lead to adverse health effects. Overconsumption of food high in carbohydrates can lead to several chronic diseases such as obesity, diabetes and cardiovascular diseases. Data from NHMS 2019 showed that cardiovascular disorders (CVDs), such as stroke and coronary heart disease, are the significant causes of mortality in Malaysia, accounting for almost half of all deaths. High blood sugar, high blood pressure, and high cholesterol are significant risk factors for these diseases.

Available carbohydrate refers to the total of free sugars (glucose, fructose, galactose, sucrose, maltose, lactose, and oligosaccharides) and complex carbohydrates (dextrins, starch, and glycogen) which is known as available carbohydrate (McCleary et al., 2019). Based on the Nutrition Information Panel (NIP), the carbohydrate content labelled is not referring to available carbohydrates. In order to obtain the available carbohydrate content, it involves the subtraction of carbohydrates with the amount of crude protein, total fat, moisture, and ash from the total sample weight (McCleary et al., 2019). However, experimental methods are more reliable in determining nutrient content. Thus, the Clegg-Anthrone method is used in this study as recommended by AOAC to determine available carbohydrates.

2.3.4 Total starch content

Starch is a source of polysaccharides under one of the categories of carbohydrates. Starch intake is associated with blood glucose levels as the rate of starch digestibility is related to the release of glucose in our bodies. Englyst et al. (1996) subcategorised the digestible starch into rapidly digested starch (RDS), slowly digested starch (SDS), and unhydrolysed starch or resistant starch (RS). The categories differentiate by hydrolysis time where RDS refers to hydrolysed during the first 30 minutes of human digestion, SDS to starch digested between 60 and 180 minutes, and RS to starch not enzymatically degraded during human digestion (0 to 180 minutes). SDS is related to sustained glucose release into the bloodstream from the small intestine lumen and decreased glycaemic, resulting in a lower insulin demand.

On the other hand, resistant starch and starch-degradation products are resistant to digestion in the small intestine (Nielsen, 2017). This study determined total starch based on McCleary et al. (2019) using the rapid total starch method. Nielsen (2017) stated that the only reliable technique for determining total starch is converting the starch to D-glucose using purified enzymes specific for starch and then measuring the D-glucose produced using an enzyme specific for it.

Several factors, including starch content, processing techniques, and non-starch components, may affect starch digestibility. Yang et al. (2021) stated that the interactions between starch, protein, fat and other ingredients substantially affect starch digestibility. Tang et al. (2019) reported that after the elimination of proteins and lipids from rice starch, the digestibility of the starch increased. In addition, Yang et al. (2021) justified that protein removal increases the starch hydrolysis rate of starch because the protein acts in preventing the binding of the amylase with the starch. Besides, in the presence of heat and moisture, SDS or RS is replaced by RDS due to structural order alterations in starch (Gourineni et al., 2017). It leads to increased accessibility to digestive enzymes and the rapid release of glucose. Thus, multiple factors influence starch digestibility that needs consider during the determination of starch content.

2.4 Indices of the Determination Estimated Glycaemic Index

In vitro starch hydrolysis was described as a simple, affordable experimental method used to estimate the glycaemic reaction of carbohydrate meals (Jenkins et al., 1987; Araya et al., 2002; Dona et al., 2010). There were different nutrients in foods that influence starch hydrolysis. These nutrients were protein content (Anderson et al., 1981; Chung et al., 2008), moisture content (Lynch et al., 2007), phosphorus content (Noda et al., 2008; Absar et al., 2009) and resistant starch (Frei et al., 2003; Deepa et al., 2010). The findings showed that carbohydrates content in that particular food was not the only nutrient that can influence starch hydrolysis.

According to Brouns et al. (2005), calculation of area under the curve (AUC) can be used in many methods depending on the purpose of the analysis in the study. Based on the finding, the methods used to calculate AUC stated as below;

- 1) All the area under the blood glucose response (total AUC)
- 2) Incremental area until first return to baseline (incremental AUC_{cut})
- 3) The area over the baseline under the curve incremental AUC and the area under the curve not included (incremental AUC)
- 4) The incremental area which using the lowest blood glucose as the baseline (incremental AUC_{min})
- 5) The net incremental AUC which applies trapezoid rule for all increment positive and negative) (net incremental AUC)

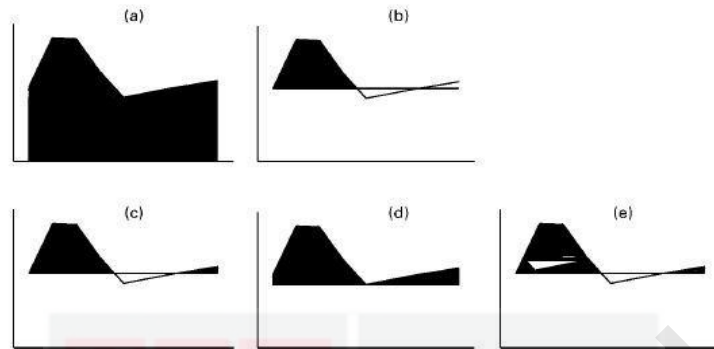


Figure 1: Different methods to determine area under the curve (AUC). (a) Total AUC; (b) Incremental AUC_{cut}; (c) incremental AUC; (d) incremental AUC_{min}; (e) Net incremental AUC (Brouns et al., 2005).

The hydrolysis index (HI) shows the rate of digestion of the starch, and the expected GI indicates the digestibility of the starch in the sample compared to the digestibility of the starch in white bread, the reference product. HI, an excellent glycaemic response indicator, was determined by dividing the AUC of each sample by the reference AUC of each reference food (white bread). The GI calculated using the following Goni et al. (1997) equation;

$$\text{Hydrolysis index, HI} = \frac{\text{AUC product}}{\text{AUC glucose (sample)}} \times 100$$

CHAPTER 3

METHODOLOGY

3.1 Sampling

3.1.1 Market survey and sample selection

A survey on the local market was conducted using the methodology of the market survey described by Ringuette et al. (2019) with slight modifications relevant for this study. Five stores were selected by using convenience sampling. The selection of stores was based on local popularity was excluded as part of the modification for this study. Instead, this study accounted for the location of stores available as convenience sampling allows for considering the easiest to obtain samples during the market survey. The stores were located in the Serdang and Seri Kembangan, Selangor with more than one location in that area and be part of a local or national chain of grocery stores.

Categories and samples of canned food were selected based on purposive sampling. Categories of the canned food were surveyed earlier and identified based on all brands available in the market. Five categories of canned food: fruits, vegetables, pulses, meat and poultry, and milk products were selected. Samples were chosen based on each category of the selected canned food obtained during the market survey. For each of surveyed canned foods, the collected data consisted of a picture (**Appendix B**) of the labelling information based on the packaging, ingredients list and

nutritional information panel (NIP) of each canned food product. The following data of labelling information (product name, product size, manufacturer declared serving size, ingredients list and the content of the nutrients) were recorded. The data obtained were tabulated in part of the result in this study. All six selected samples were brought to the Universiti Putra Malaysia (UPM) laboratory and stored based on their preferable condition before being analysed in this study.

3.1.2 Sample preparation

All the samples were brought into the Dietetic Lab, Faculty of Medicine and Health Sciences and stored in the chiller before undergoing the homogenisation process. The samples were homogenised using a food processor (National MK-5070N, Osaka, Japan) and stored in a plastic container for further use. Each of the samples with the required amount was brought to Institute Biosains, UPM, for the freeze-drying process before being used in the study analysis.

3.1.3 Sampling design

The experimental design was illustrated in **Figure 2**.

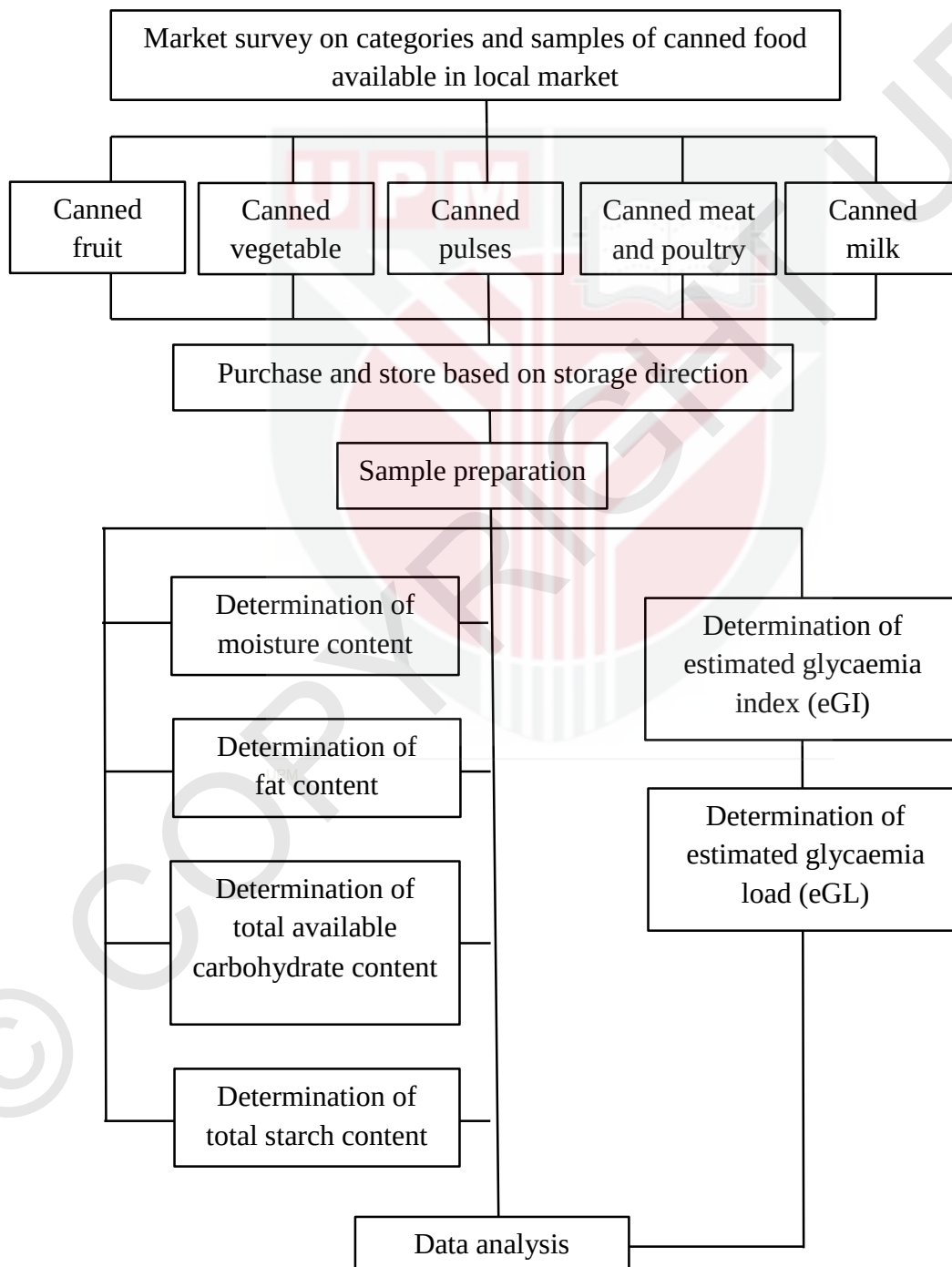


Figure 2: Experimental design of determination *in vitro* glycaemic index of selected canned foods in the local market.

3.2 Materials

3.2.1 Reference food

White bread and glucose were used as the reference food. The aim was to observe the difference in estimated glycaemic index values when using both reference foods. However, Venn et al. (2014) stated that a standard such as white bread is more relevant when evaluating the glycaemic response to food containing carbohydrates. The use of glucose as a reference for sugary foods may be acceptable. In short, glucose is a good indicator of sugary foods, not even starchy foods. Similarly, using a starchy meal as a reference food for analysing sugary food would be inappropriate.

3.2.2 Samples

Canned fruit of lychee in heavy syrup (LHS), canned vegetables of sweet corn cream styles (SCCS), canned pulses of baked beans in tomato sauce (BBTS), canned meat of beef curry with potatoes (BCWP), canned poultry of chicken curry with potatoes (CCWP) and canned milk of sweetener creamer (SC). The samples are as illustrated in **Appendix B**.

3.3 Chemical and Reagents

Amyloglucosidase (3300U/mL) (Solarbio), pepsin from porcine gastric mucosa-powder (P7000-25G) (Sigma-Aldrich, United Kingdom), D-(+)-Glucose anhydrous-CP, 73315 (Chemiz, Malaysia), glucose (Glucolin, Thailand), D-Glucose (GOPOD Format) assay kit (Megazyme, Ireland), sodium acetate buffer solution (3M; pH 5.2) (Sigma-Aldrich), Trizma® maleate salt (Sigma-Aldrich), sodium acetate anhydrous (Sigma-Aldrich), potassium hydroxide-pellet (R&M Chemicals, Malaysia), calcium chloride (Merck, Germany), sodium chloride (Merck, Denmark), sulfuric acid 98% (Merck, Belgium), α -Amylase (*Aspergillus oryzae*) (120 U/mg) (Megazyme, Ireland), α -amylase heat stable, hydrochloric acid (37%) (Fisher Scientific, Malaysia), perchloric acid (70%), potassium chloride (AJA383-500G) (AJAX-Finechem (Univar)), petroleum ether 40-60 °C (Fisher Scientific, Malaysia), anthrone powder.

3.4 Equipment

Laboratory drying oven, FreeZone 4.5 litre benchtop freeze dry system (Labconco), Forma™ 900 Series -86°C upright ultra-low temperature freezers (Thermo Fisher Scientific), Sartorius-PB-10 basic benchtop pH meter (Sartorius), GF-300 digital scale (A&D Weighing), GR-200 analytical semi-micro balance (A&D Weighing), spectrophotometer UV-1800 (Shimadzu, Japan), water bath (Memmert, Germany), soxhlet system HT Tecator, Hei-Tec magnetic stirrers (Heidolph, Germany), IKA vortex 1, chemical-resistant diaphragm vacuum pump, Hwashin ultrasonic cleaner-power sonic 405 (Copens Scientific), ROTOFIX 32 centrifuge (Hettich), rotavapor R-200 including bath B-490 (Büchi), vacuum controller V-800 (Büchi), food processor (National MK-5070N, Osaka, Japan)

3.5 Determination of Moisture Content

The determination of moisture content is conducted to determine the moisture of the analysed food samples as the moisture may influence the estimation of GI. Moisture content also required for further determination of starch content for the studied samples that used wet weight. Based on that, the dry weight basis of those samples can be obtained by determining the moisture content. The moisture content of the samples was determined using the oven- drying based on the method done by AOAC (2000). The samples were ground finely or homogenised by using a blender and mixed thoroughly. In a 105 °C oven, an aluminium dish was dried with a cover for 3 hours. Then, the dish was cooled in a desiccator and weighed immediately when it reaches room temperature. Ten grams of the homogenised sample was weighed out and added to the aluminium dish. A dish was set with a sample in it, uncovered, at a temperature of 105 °C overnight. The cover was replaced while the dish is still in the oven. After that, the dish from the oven was removed and cooled in the desiccator. The sample was weighed once it reached room temperature. The process was repeated until it reached a consistent weight of the sample.

The moisture content of the sample was calculated as expressed below:

Moisture content, % by weight:

$$\frac{\text{loss of weight of the sample (g)}}{\text{weight of the sample taken (g)}} \times 100$$

3.6 Determination of Fat Content

The determination of fat content was conducted for the samples that contain more than 5 % of fat based on their NIP for further use in the estimation of eGI. The determination also aims to determine the correlation of analysed fat content with the eGI. The fat content of the sample was determined based on a Soxhlet method described by AOAC (2000).

Ten grams of sample was weighed and placed into an extraction thimble. The thimble was placed in an extraction chamber suspended above a weighed flask containing 200 mL petroleum ether and below a condenser. The Soxhlet extraction instrument was left for 8 - 16 hours under reflux for lipid extraction. Then, the petroleum ether was removed by using a rotary evaporator through evaporation. The flask was dried in an air oven at 100 °C for about 1 hour. The flask was transferred to a desiccator for the cooling process and weighed once it attained room temperature. The process was repeated until the results of two successive weighing do not differ by more than 0.1 % of the mass of the test portion.

The fat content of the sample was calculated as expressed below:

Fat content, % by weight:

$$\frac{W - W_0}{W_{\text{sample}}} \times 100$$

W_0 : weight of the flask without fat (g);

W : weight of the flask with fat (g);

W_{sample} : weight of the sample was taken (g).

3.7 Determination of Total Available Carbohydrate Content

The total available carbohydrate content was analysed to determine if there is any correlation with the eGI. The total available carbohydrate content of the sample was determined by the colorimetric Clegg anthrone method described by Peris-Tortajada (2004).

For the sample extraction, 2.5 g of wet sample was weighed and placed into a 100 mL stoppered graduated cylinder. Then, 10 mL of water was added and stirred using a glass rod for a sample to disperse thoroughly. The mixture was added with 13 mL of 52% Perchloric acid and frequently stirred for at least 20 minutes using a glass rod. The rod was washed with water after use, and the mixture was diluted to 100 mL. After that, the mixture was mixed and filtered into a 250 mL volumetric flask. The cylinder was then washed with water and poured into the volumetric flask. Lastly, the mixture was diluted with water until the mark of 250 mL and mixed thoroughly.

The extracted sample then was determined based on the following steps. Initially, 10 mL of the sample extract was diluted to 100 mL with water. From the dilution, 1 mL of the solution was extracted and diluted to 10 mL with water (applied for sample sweetened creamer and lychee). Next, 1 mL of diluted sample extract/ water/ glucose standard working solution was pipetted into a test tube. Then, 5 mL of Anthrone reagent was added immediately to each test tube, and the mixture was mixed thoroughly. After precisely 12 minutes in a boiling water bath, the mixture was cooled quickly to room temperature. Lastly, the total available carbohydrate content was measured based on the absorbance reading of the reaction mixture at 630 nm against blank.

The total available carbohydrate content of the sample was calculated as expressed below:

Total available carbohydrate content, % glucose by weight:

$$\frac{25 - b}{a \times w}$$

a: absorbance of glucose standard working solution;

b: absorbance of sample extract;

w: weight of the sample was taken (g).

Note: Standard curve shows a straight line over the 0-0.15 mg/ml glucose solution.

3.8 Determination of Total Starch Content

The determination of total starch content used the rapid total starch method by McCleary et al. (2019). The assay was conducted to determine the weight of studied samples required that contains 50 mg of starch. For that reason, the determination of *in vitro* eGI requires the use of samples with 50 mg of starch content. Besides, the determination of total starch content also required to provide the data for the rate of starch hydrolysis. The rate of starch hydrolysis is an indicator of starch digestibility in the analysed food samples.

The procedure began as approximately 100 mg of dried sample were weighed and placed in a test tube. On the other hand, another test tube was prepared with the same sample as the sample blank. Then, 10 mL of sodium acetate buffer (0.1 M; pH 5.0, containing 5 mM calcium chloride, CaCl_2) were added to both sample and blank test tubes; and shaken well after that. Next, 0.1 mL of thermostable α -amylase was added to the sample test tube, while 0.1 mL of sodium acetate buffer solution (0.1 M; pH 5.0, containing 5 mM calcium chloride, CaCl_2) was added the blank test tube. Then, both test tubes were mixed using vortex before capped using aluminium foil to be incubated

in a 100 °C boiling water bath for 15 minutes. In each 5 minutes interval, the test tubes were taken out and shaken to mix the mixture. After incubated, the test tubes were then cooled by incubated in a 60 °C water bath for 5 minutes.

After cooled, the sample test tube was added with 0.1 mL of amyloglucosidase (3300 U/mL) while the blank test tube was added with 0.1 mL of sodium acetate buffer solution (0.1 M; pH 5.0, containing 5 mM calcium chloride, CaCl_2). The test tubes were capped back and incubated in a 60 °C water bath for about 30 minutes. In each 15 minutes interval, the test tubes were shaken thoroughly to homogenise the enzyme with the mixture. After removed the test tubes from the water bath, the test tubes were emptied by transferred the mixture into 15 mL centrifuge tubes. The tubes then were centrifuged (4000 rpm/5 minutes). After that, 1.0 mL of supernatant from the sample tube was pipetted into a new test tube for further dilution. On the other hand, 0.1 mL of blank solution was pipetted into a new test tube for the GOPOD reagent procedure later. In the sample test tube, 4.0 mL of sodium acetate buffer solution (0.1 M; pH 5.0, containing 5 mM calcium chloride, CaCl_2) were added to dilute the sample using a 5-fold dilution factor.

After the dilution, 0.1 mL of the diluted sample solution transferred into new test tubes for the GOPOD reagent procedure. In both sample and blank test tubes, 3.0 mL of GOPOD reagent was added and then incubated in a 50 °C water bath for 20 minutes. The absorbance then read at 510 nm against the GOPOD reagent blank (0.1 mL 0.1 M sodium acetate buffer solution; 3.0 mL GOPOD reagent) using a spectrophotometer. The analysis will be carried out in triplicate for the sample, while the analysis only carried out once for the sample blank for each sample.

The total starch content was determined based on the equation below and expressed on a % (w/w) as-is basis;

$$\text{Total starch, \%} = \Delta A \times F \times 102 \times D \times 1/1000 \times 100/W \times 162/180$$

Where,

ΔA : absorbance of sample solution read against reagent blank/the absorbance of the sample blank read against the reagent blank;

F: factor of conversion absorbance values to μg glucose (100 μg glucose divided by the absorbance value obtained for 100 μg of glucose);

102: volume correction, (0.1 mL taken from 10.2 mL of sample solution);

D: further dilution of sample solution (either undiluted, 5-fold or 11-fold);

1/1000: conversion from μg to mg;

100/W: conversion to 100mg sample;

162/180: factor to convert from free glucose, as determined, to anhydroglucose, as occurs in starch.

3.9 Estimation of Glycaemic Index

There were two reference foods used, which are white bread and glucose. Venn et al. (2014) stated that a standard such as white bread is more relevant when evaluating the glycaemic response to food containing carbohydrates. The use of glucose as a reference for sugary foods may be acceptable. In short, glucose is a good indicator of sugary foods, not even starchy foods. Similarly, using a starchy meal as a reference food for analysing sugary food would be inappropriate.

3.9.1 *In vitro* of starch digestion

The method was adapted from Goni et al. (1997) modified by Graca et al. (2021). For sample preparation, an adequate amount of samples were freeze-dried initially. Freeze drying was applied to samples with more than 5 % fat (sweetened creamer, beef curry with potatoes and chicken curry with potatoes) followed by defatted using Soxhlet extraction with petroleum ether (Soxhlet System HT Tecator).

The samples containing approximately 50 mg total starch were dissolved in HCL-KCL buffer (0.1 M; pH 1.5) and incubated with 0.2 mL pepsin (1 g/10 mL HCL-KCL, 220 U/mL) at 40 °C for 1 hour to simulate the gastric phase preventing protein-starch interactions. After that, 25 mL of Tris-maleate buffer solution (0.1 M, pH 6.9) was added to the mixture to halt the enzyme reaction and produce optimal conditions for the small intestine digestion or pancreatic phase to begin, which was imitated by adding 5 mL of α -amylase solution (3 U/mL) and incubated at 37 °C. Every 30 minutes interval, 5 mL of aliquots of sample solution were collected at different times ($t =$

0,30,60,90,120 and 180 minutes). The aliquots were placed in the water bath boiling for 5 minutes to stop the enzymatic reaction and maintained under cold conditions (until 180 min of incubation).

Three millilitres of sodium acetate buffer (0.4 M; pH 4.75) and 60 μ L of amyloglucosidase (3300 U/mL) were used to treat aliquots. Then, the aliquots were incubated for 45 min at 60 °C and centrifuged (4000 rpm/5 min) at room temperature. 100 μ L of the supernatant was diluted based on dilution 11-fold with 1 mL sodium acetate buffer (0.4 M; pH 4.75) in a 2 mL microcentrifuge tube. After that, 0.1 mL aliquots of solution from each sample were transferred into a new tube, and 3 mL of GOPOD reagent was added. The solutions were incubated at 50 °C for 20 minutes and measured the absorbance at 510 nm against the reagent blank (3 mL GOPOD reagent; 0.1 mL buffer) to determine the glucose content in each sample. The reagent blank absorbance solution should be less than 0.05 when read against distilled water.

3.9.2 Estimation of rate of starch hydrolysis (RSH)

The rate of starch hydrolysis was calculated according to the established method of Goni et al. (1997) based on the equation as described below.

The rate of starch hydrolysis for sample weighed 100 mg was calculated as expressed by Equation 1 (a);

$$\left(\frac{a}{b} \times 100\right) \times 11 \times 0.9 \dots \dots \dots 1 \text{ (a)}$$

Where,

a: average reading absorbance of sample at different t = 30,60,90,120,and 180 minutes;

b: average reading absorbance of standard solution.

The rate of starch hydrolysis for sample weighed more than 100 mg was calculated as expressed by Equation 1 (a) and 1 (b);

$$\left(\frac{RSH}{c} \times 100\right) \times 11 \times 0.9 \dots \dots \dots 1 \text{ (b)}$$

Where,

RSH: rate of starch hydrolysis per 100 mg (equation 1 (a));

c: weight of sample was taken (g)

3.9.3 Estimation of area under curve, hydrolysis index and glycaemic index

The area under the curve (AUC) was calculated using Graphpad Prism version 8.0.1.

The hydrolysis index (HI) was obtained from value AUC of sample and reference food obtained from analysis as described above and calculated based on the equation below;

$$\frac{AUC \text{ of sample}}{AUC \text{ of reference food}} \times 100$$

The estimated glycaemic index (eGI) was obtained based on the equation below;

$$eGI = 39.71 + 0.549 HI$$

3.10 Estimation of Glycaemic Load

The estimated glycaemic load was determined based on the equation expressed by Kumar et al. (2020) as calculated below;

$$\frac{eGI \times \text{Net available carbohydrate per serving size (g)}}{100}$$

In this experiment, the net available carbohydrate per serving size (g) was obtained from the Nutrition Information Panel of the sample product.

3.11 Design and Statistical Analysis

Results are expressed as mean values $\pm$ standard deviation for triplicate samples. Data collected were analysed using a one-way analysis of variance (ANOVA) to compare the mean between the samples for moisture, fat, total available carbohydrate, total starch, estimated glycaemic index and estimated glycaemic load. Post hoc tests of Tukey's Honest Significant Difference test (Tukey's *HSD*) was used to determine specific differences between means values of each group as the values were significantly different. Pearson Correlation was used to determine the correlation between estimated glycaemic index with estimated glycaemic load and the analysed total available carbohydrate and fat content of the selected canned food. The data was performed using Statistical Package for Social Science (SPSS) version 25.0 software. The statistical significance was determined by *p* values less than 0.05 ($p < 0.05$).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Determination of Nutrient Composition Based on Nutrition Information Panel (NIP).

The composition of carbohydrate, fat, total sugar and protein content of the analysed food samples (per 100 g) based on the Nutrition Information Panel (NIP) is presented in **Table 1**. Among the analysed food samples, it was observed that the carbohydrate content of samples ranged from 7.0 g/100 g to 60.2 g/100 g. The carbohydrate content of SC was discovered to be the greatest (60.2 g/100 g), followed by BCWP (7.0 g/100 g) and CCWP (7.0g/100 g), both of which had the lowest amounts of carbohydrate. Generally, sweetened creamer or condensed milk (CM) is a dairy product made by evaporating part of the water (60%) from whole or skim milk with the addition of sugar for sweetened condensed milk (SCM) (Jafari et al., 2021). The addition of sugar contributes to carbohydrate content in the food as sugar is one of the carbohydrates components (RNI, 2017). According to Brunt et al. (2020), the sugars in sweetened condensed milk were sucrose and lactose. Based on the ingredients recorded (**Appendix B**), sugar is the main ingredient list that may contribute to the high amount of carbohydrate content in SC.

Table 1. The nutrient composition of the analysed food samples (per 100 g) based on Nutrition Information Panel (NIP) as provided by the manufacturer.

Sample	Carbohydrate (g/100 g)	Fat (g/100 g)	Total sugar (g/100 g)	Protein (g/100 g)
BBTS	14.5	0.5	NA	4.1
SCCS	11.4	0.6	NA	1.4
SC	60.2	10.0	NA	2.0
BCWP	7.0	13.0	NA	13.0
CCWP	7.0	8.0	NA	12.0
LHS	22.8	0.0	21.7	0.6

Abbreviations: BBTS: baked beans in tomato sauce; SCCS: sweet corn cream style; SC: sweetened creamer; BCWP: beef curry with potatoes; CCWP: chicken curry with potatoes; LHS: lychee in heavy syrup; NA: not available.

The above data shows that fat content ranged from 0.0 g/100 g to 13.0 g/100 g. In contrast to carbohydrate content, the BCWP had the highest fat content (13.0 g/100 g) compared to the LHS with 0.0 g/100 g of fat. During the sample preparation, it was found that the surface of the meat was mostly covered with fat. Thus, it is assumed that those fats may have contributed to the fat content in BCWP besides other ingredients used, such as coconut (**Appendix B**). In contrast to LHS, lychee fruit is a high source of carbohydrate and fibre, while fats and proteins are scarce (Emanuele et al., 2017).

Protein content was in the range of 0.6 g/100 g to 13.0 g/100 g. The highest protein content was found in BCWP, while the lowest protein was in LHS with values of 13.0 g/100 g and 0.6 g/100 g, respectively. Beitane et al. (2021) stated that the canned beef, chicken, pork, and legumes are grouped into protein-dense products. Tessema et al. (2018) clarified that due to the current lack

of essential amino acids such as lysine and tryptophan, animal-based proteins are recommended for children's diets (Schönfeldt & Gibson et al., 2012). The high biological value of most meat proteins is due to the presence of many essential amino acids. Li (2017) stated that the body does not synthesize the vast majority of the essential amino acids found in beef and must be obtained through the diet. In order to fulfil the demand of growing children, it is essential to feed them with appropriate amounts of high-quality protein (Uauy et al., 2015).

Among the nutrients recorded, only total sugar content of the LHS sample (21.7 g/100 g) was stated, while other samples did not provide total sugar content in their NIP. Based on the ingredients recorded (**Appendix B**), sugar is the second high on the ingredient list, contributing to the reported total sugar content (21.7 g/100 g). According to National Center for Home Food Preservation (NCHFP) (2018), heavy syrup consisted of approximately 40% of sugar (water, sugar and corn syrup). Corresponding to heavy syrup stated on the packaging of LHS, it may explain the high amount of sugar content in LHS. Besides, the nutrient composition in the lychee pulp also influences the analysed nutrient content. Hajare et al. (2010) explained that sugars are the significant nutrient in *litchi* (scientific name of lychee) pulp, accounting for up to 10.0 to 19.2% of the total, reducing sugars contributing to 70% of the total. Sucrose, fructose, and glucose are the three main sugars in *litchi* pulp, with approximately equal fructose and sucrose content (Yang et al., 2013).

4.2 Determination of Total Available Carbohydrate, Total Starch, Fat and Moisture Content

The results on total available carbohydrates, total starch, fat and moisture content are tabulated in **Table 2**. The amount of total available carbohydrates was higher among the analysed food samples [$F(5, 12) = 251.22, p < 0.05$]. BBTS had the highest value (29.70 ± 0.16), followed by SC (17.13 ± 0.52), SCCS (13.51 ± 1.70), CCWP (10.38 ± 0.83) and LHS (7.86 ± 0.47). However, BCWP (8.19 ± 0.87) showed no significant difference with CCWP (10.38 ± 0.83) and LHS (7.86 ± 0.47).

Conversely, total starch content varied significantly [$F(5, 12) = 384.24, p < 0.05$]. LHS (3083.49 g/100 g) and SCCS (3252.89 g/100 g) had the highest total starch content, followed by BBTS (2838.65 g/100 g), CCWP (1229.60 g/100 g) and BCWP (739.03 g/100 g) and SC (687.53 g/100 g). Nevertheless, LHS (3083.49 g/100 g) showed no significant difference with SCCS (3252.89 g/100 g) and BBTS (2838.65 g/100 g). Similarly, the total starch content between BCWP (739.03 g/100 g) and SC (687.53 g/100 g) showed no significant difference.

Table 2. Amount of total available carbohydrate, total starch, fat and moisture content of analysed food samples.

Sample	Total available carbohydrate content (%) ¹ (n=18)	Total starch content (g/100 g) ² (n=18)	Fat content (%) ² (n=9)	Moisture content (%) ¹ (n=18)
BBTS	29.70 ± 0.16 ^a	2838.65 ± 24.63 ^b	NA	75.41 ± 0.89 ^b
SCCS	13.51 ± 1.70 ^c	3252.89 ± 98.48 ^a	NA	83.92 ± 0.78 ^a
SC	17.13 ± 0.52 ^b	687.53 ± 103.47 ^d	0.43 ± 0.20 ^c	25.89 ± 0.31 ^e
BCWP	8.19 ± 0.87 ^{de}	739.03 ± 27.82 ^d	30.53 ± 2.58 ^b	71.16 ± 0.19 ^d
CCWP	10.38 ± 0.83 ^d	1229.60 ± 196.69 ^c	38.25 ± 2.93 ^a	72.78 ± 0.24 ^c
LHS	7.86 ± 0.47 ^e	3083.49 ± 91.54 ^{ab}	NA	85.05 ± 0.22 ^a

Note: Values are presented as mean ± standard deviation. Different superscripts (a, b, c, d, e) in the same column indicate that there are significant statistical differences between analysed food samples (ANOVA $p < 0.05$, Tukey's test). Where, superscript 1 and 2 indicates the values were based on wet and dry-basis weight, respectively.

Abbreviations: BBTS: baked beans in tomato sauce; SCCS: sweet corn cream style; SC: sweetened creamer; BCWP: beef curry with potatoes; CCWP: chicken curry with potatoes; LHS: lychee in heavy syrup; NA: not available.

Among the analysed food samples, fat content showed significant difference [$F(2,6) = 235.18, p < 0.05$]. The analysis was only available for SC, BCWP and CCWP as these are the samples with a fat content of more than 5% (based on NIP). Results showed fat content was significantly higher in CCWP (38.25 ± 2.93) compared to BCWP (30.53 ± 2.58) and SC (0.43 ± 0.20).

These findings were not comparable with the NIP, which may be influenced by other factors such as the extraction method. A study done by Pérez-Palacios et al. (2018) found that the method used for extraction of fat on meat was more effective when using the Soxhlet and Folch method. In contrast, the fat content extracted from the Bligh and Dyer method resulted in the lowest fat content for all meat. Thus, it could be explained by the high-fat content of BBWP and CCWP compared to the NIP value. In addition, SC showed the lowest analysed fat content compared to NIP. Hewavitharana et al. (2020) reported some standard fat extraction and derivatization methods used in various food categories. The milk fat extraction from dairy products was found most suitable using Folch and Bligh and Dyer method. Apart from that, there was almost no difference in fat (crude) content between the Folch and automated Soxhlet methods, and the automated Soxhlet technique generated more SFAs, MUFAs, and PUFAs (Hewavitharana et al., 2020).

Corresponding to that, ingredients of SC showed it contains refined palm oil (**Appendix B**). Mancini et al. (2015) stated that palmitic acid, a saturated fatty acid, is the most prevalent ingredient in refined palm oil. Hence, the content of refined palm oil in the SC may contribute to the fat content of SC as a saturated fatty acid. Even so, the Soxhlet method used in this study is conventional and not automated. It is suggested that the milk fat extraction for SC in this study may provide better results of fat content if using the automated Soxhlet method.

Moreover, the moisture content of the analysed food samples showed a significant difference [$F(5, 12) = 5229.54, p < 0.05$]. The moisture content is ranging from 25.89% to 83.92%. Moisture content of LSH (85.05 ± 0.22) and SCCS (83.92 ± 0.78) were significantly higher compared to BBTS (75.41 ± 0.89), CCWP (72.78 ± 0.24), BCWP (71.16 ± 0.19) and SC (25.89 ± 0.31). LSH was found to have a higher moisture content as the main ingredients consist of lychee water (**Appendix B**). The result demonstrated that BBTS has lower moisture content because the cooking medium for baked beans in tomato sauce has lower water content (Farinde et al., 2017).

4.3 Estimation of Glycaemic Index

4.3.1 Total starch hydrolysis

Generally, the reference foods, which are glucose and WB, had the highest rate of starch hydrolysis, followed by the analysed food samples (**Figure 3**). At 30 minutes, the reference foods, glucose, and WB demonstrated the rate of 95.10% starch/min and 54.01% starch/min of starch hydrolysis, respectively. SC exhibited only 2.73% starch/min of starch hydrolysis. After 90 minutes, the hydrolysis rate increased slightly, but starch hydrolysis of SCCS (32.09% starch/min) decreased to 28.08% starch/min. The starch hydrolysis plateaus were achieved at 120 minutes for the analysed food samples. However, LHS attained a peak (33.60% starch/min) at 120 minutes and decreased (28.20% starch/min) towards 180 minutes. Meanwhile, starch hydrolysis at 120 minutes for WB (74.22% starch/min) and SCCS (28.08% starch/min) were increased towards 180 minutes with (78.99% starch/min) and (31.92% starch/min), respectively.

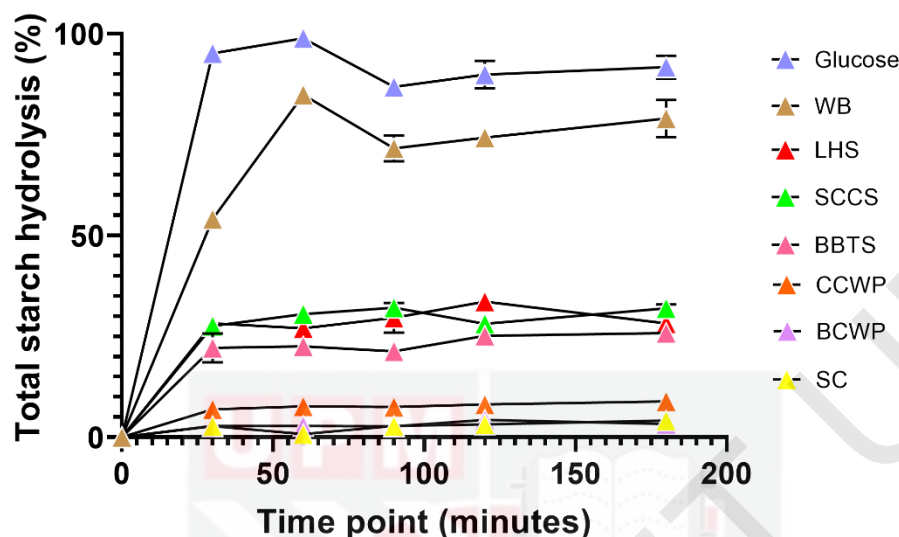


Figure 3: Total starch hydrolysis (%) of analysed food samples and reference food. Error bars represent standard error of the mean.

Adapted from: Created by using Graphpad Prism version 8.0

Abbreviations: WB: white bread; LHS: lychee in heavy syrup; SCCS: sweet corn cream style; BBTS: baked beans in tomato sauce; CCWP: chicken curry with potatoes; BCWP: beef curry with potatoes; SC: sweetened creamer.

The starch hydrolysis index (HI) was determined by comparing the proportion of total glucose released from the samples to that released from standard glucose (0–180 minutes) (Goni et al., 1997). Starch digestibility is classified into three categories which are rapidly digested starch (RDS), slowly digested starch (SDS), and resistant starch (RS) (Englyst et al., 1996). RDS refers to starch that being hydrolysed during the first 30 minutes of human digestion. Meanwhile, SDS is hydrolysed between 60 and 180 minutes. RS is a starch that is not hydrolysed during human digestion.

Based on the *in vitro* study by Yang et al. (2021), starch digestibility is strongly influenced by the interactions between starch, protein, fat, and other components. Tang et al. (2019) reported that removing proteins and lipids leads to increased digestibility of rice starch. Furthermore, less availability of dietary fibre and less protein content could have led to the rapid digestion of starch-rich food such as cassava and potato (Hettiaratchi et al., 2009). Agama-Acevedo et al. (2019) explained that whole grains digest more slowly than grains without the bran. It may be due to dietary fibre from the bran layer, which can restrict the adhering of starch and prevent the interaction between the enzymes and starch.

Multiple studies found that protein removal attributed to the increase of the starch hydrolysis of the analysed food samples. Starch is composed of two types of polysaccharides which are amylose and amylopectin. Yu et al. (2018) and Zou et al. (2015) found that the proteins partially absorbed the amylase, resulting in a decreased enzyme utilisation rate. Moreover, the presence of protein also inhibited the binding of amylase-starch. According to Munira et al. (2018), the presence of protein and lipid leads to interaction between starch, forming starch-protein and starch-lipid. Thus, the interaction of starch-lipids formed an inclusion complex, called amylose-lipid complex (ALC), which can influence starch characteristics. Starch-protein and starch-lipid interaction would help inhibit the enzymatic mechanism with starch and lower the starch digestibility (Munira et al., 2018).

Corresponding to the rate of starch hydrolysis for SCCS, the graph showed that the rate of starch hydrolysis rapidly increased at an initial time. It could be explained as SCCS is a starchy food (Lal et al., 2020) with low protein content (1.4 g/100 g). According to Barine & Yorte (2016), greater total starch content resulted in higher digestible starch. It can be seen in SCCS and LHS, which had higher total starch content (**Table 2**) and rate of starch hydrolysis in the initial 30 minutes (**Figure 3**). Moreover, BCWP and CCWP contained potatoes that are rich in starch. Potatoes are a source of tuber rich in starch and high resistant starch (RS) (Lal et al., 2020). According to Lal et al. (2020), the raw potatoes had the highest RS (70%) compared to cooked potatoes (5% - 10%). BCWP and CCWP contain cooked potatoes which are found to have low RS after the cooking process. However, the low rate of starch hydrolysis can be attributed to RS and protein components as BCWP and CCWP are rich protein sources.

Based on the findings of Lal et al. (2020), potato varieties including (Kufri Jyoti and Kufri Chipsona 3). Based on their findings, Kufri Jyoti (2.18%) had the greatest RS and the lowest GI (72.87 0.09), whereas Kufri Chipsona 3 (1.08%) had the lowest RS and the highest GI (83.08 0.15). These results were supported by statistical analysis where RS and GI were highly significant and negatively correlated ($R=-0.88$) ($p<0.05$) (Lal et al., 2020). A negative correlation refers to an increase in RS that reduce the GI response. From these results, it was clear that cultivars (potatoes) with low RS content had a faster rate of starch hydrolysis, resulting in a higher GI (Lal et al., 2020).

4.3.2 Determination of hydrolysis index (HI), estimated glycaemic index (eGI) and estimated glycaemic load (eGL).

The GI values of the analysed food samples were classified based on ISO 2442:2010 (2010), as low (≤ 55), medium (56–69) and high (≥ 70). It was found that both reference foods had the highest GI, followed by medium GI (BBTS, SCCS and LHS) and lowest GI (SC, BCWP and CCWP). GL values were classified based on Venn and Green (2007) as low (≤ 10), medium (11–19) and high (≥ 20). Based on the data obtained, both reference foods had high GL, while all analysed food samples (except LHS with medium GL) had low GL. The values of HI, eGI and eGL of the reference foods and analysed food samples are presented in **Table 3**.

Table 3. Hydrolysis index (HI), estimated glycaemic index (eGI) and estimated glycaemic load (eGL) of the analysed food samples (n=24).

Sample	Hydrolysis Index		Estimated Glycaemic Index		Estimated Glycaemic Load	
	HI ₁	HI ₂	eGI ₁	eGI ₂	eGL ₁	eGL ₂
BBTS	32.29 ± 1.32 ^d	25.51 ± 1.04 ^d	57.44 ± 0.72 ^d	53.72 ± 0.57 ^d	8.85 ± 0.11 ^e	8.27 ± 0.09 ^e
SCCS	40.98 ± 0.94 ^c	32.37 ± 0.74 ^c	62.21 ± 0.52 ^c	57.48 ± 0.41 ^c	6.03 ± 0.05 ^f	5.58 ± 0.38 ^f
SC	3.79 ± 0.23 ^f	2.99 ± 0.18 ^f	41.79 ± 0.13 ^f	41.35 ± 0.10 ^f	5.01 ± 0.02 ^g	4.96 ± 0.02 ^g
BCWP	4.49 ± 0.20 ^f	3.55 ± 0.16 ^f	42.17 ± 0.11 ^f	41.66 ± 0.09 ^f	8.43 ± 0.02 ^e	8.33 ± 0.02 ^e
CCWP	10.75 ± 0.10 ^e	8.49 ± 0.08 ^e	45.61 ± 0.06 ^e	44.37 ± 0.05 ^e	9.58 ± 0.01 ^d	9.32 ± 0.01 ^d
LHS	40.77 ± 1.05 ^c	32.21 ± 0.83 ^c	62.09 ± 0.58 ^c	57.39 ± 0.46 ^c	19.87 ± 0.19 ^c	18.36 ± 0.15 ^c
Reference food						
WB	100.00 ± 0.99 ^b	79.01 ± 0.79 ^b	94.61 ± 0.55 ^b	83.09 ± 0.43 ^b	28.57 ± 0.17 ^b	25.09 ± 0.13 ^b
Glucose	126.57 ± 2.11 ^a	100.00 ± 1.67 ^a	109.20 ± 1.16 ^a	94.61 ± 0.92 ^a	43.57 ± 0.46 ^a	37.75 ± 0.37 ^a

Note: Values are presented as mean ± standard deviation. Different superscripts (a, b, c, d, e, f, g) in the same column indicate that there are significant statistical differences between analysed food samples (ANOVA $p < 0.05$, Tukey's test). HI, eGI and eGL represent hydrolysis index, estimated glycaemic load and estimated glycaemic index, respectively. Subscripts 1 and 2 for HI, eGI, and eGL, respectively, represent white bread and glucose. GI values were classified as low (≤ 55), medium (56–69) and high (≥ 70) (ISO 26642:2010, 2010). GL values were classified as low (≤ 10), medium (11–19) and high (≥ 20) (Venn & Green, 2007).

Abbreviations: BBTS: baked beans in tomato sauce; SCCS: sweet corn cream style; SC: sweetened creamer; BCWP: beef curry with potatoes; CCWP: chicken curry with potatoes; LHS: lychee in heavy syrup; WB: white bread.

4.3.2.1 Hydrolysis index (HI₁), estimated glycaemic index (eGI₁) and estimated glycaemic load (eGL₁) with white bread (WB) as the reference food.

The values of hydrolysis index (HI) showed significant differences among white bread (WB), glucose and analysed food samples [$F(7, 16) = 5313.64, p < 0.05$]. HI is ranging from 3.79 ± 0.23 to 126.57 ± 2.11 . Glucose had significantly higher values (126.57 ± 2.11) compared to WB (100.00 ± 0.99). Following that, the HI of SCCS (40.98 ± 0.94) and LHS (40.77 ± 1.05) were higher than BBTS (32.29 ± 1.32), CCWP (10.75 ± 0.10), and BCWP (4.49 ± 0.20) and finally SC (3.79 ± 0.23).

The estimated glycaemic index (eGI) is a product of HI based on a published formula. The eGI varied significantly [$F(7, 16) = 5321.56, p < 0.05$]. Similarly, eGI of the reference food and analysed food samples showed the same trends with HI. Glucose represents the highest eGI (109.20 ± 1.16) than WB (94.61 ± 0.55). The analysed food samples of SCCS and LHS presented higher eGI of 62.21 ± 0.52 and 62.09 ± 0.58 , respectively. Next, the eGI of BBTS (57.44 ± 0.72) was significantly different from CCWP (45.61 ± 0.06), BCWP (42.17 ± 0.11) and SC (41.79 ± 0.13).

The estimated glycaemic load (eGL) is a product of eGI computed based on a published formula. The trends of eGL were found different from HI and GI. The eGL among the reference food and the analysed food samples were significantly different [$F(7, 16) = 15414.21, p < 0.05$]. Based on the calculation eGL, glucose had the highest value of eGL (43.57 ± 0.46) than WB (28.57 ± 0.17). Following that, eGL of LHS was higher (19.87 ± 0.19) than other analysed food samples of CCWP (9.58 ± 0.01), BCWP (8.43 ± 0.02) and BBTS (8.85 ± 0.11), SCCS (6.03 ± 0.05) and SC (5.01 ± 0.02) with the lowest eGL.

4.3.2.2 Hydrolysis index (HI₂), estimated glycaemic index (eGI₂) and estimated glycaemic load (eGL₂) with glucose as the reference food.

Trends of HI within the analysed food samples were similar to WB. The values of HI varied significantly [$F(7, 16) = 5317.91, p < 0.05$]. Glucose had a higher value of HI (100.00 ± 1.67) than WB (79.01 ± 0.79). Similarly, SCCS and LHS had higher HI with 32.37 ± 0.74 and 32.21 ± 0.83 , respectively. Following that, the HI of BBTS is 25.51 ± 1.04 , CCWP is 8.49 ± 0.08 , and BCWP is 3.55 ± 0.16 , and SC is 2.99 ± 0.18 .

Next, the estimated glycaemic index (eGI) between the reference food and analysed food samples varied significantly [$F(7, 16) = 5318.94, p < 0.05$]. Glucose had the highest eGI (94.61 ± 0.92) than WB (83.09 ± 0.43). The analysed food samples of SCCS and LHS had higher eGI with 57.48 ± 0.41 and 57.39 ± 0.46 , respectively. Next, BBTS (53.72 ± 0.57) had significantly different eGI from CCWP (44.37 ± 0.05) and BCWP (41.66 ± 0.09) and SC (41.35 ± 0.10).

The eGL of reference food and the analysed food samples were significantly different [$F(7, 16) = 17758.71, p < 0.05$]. Glucose had the highest value of eGL (37.75 ± 0.37) than WB (25.09 ± 0.13). Following that, eGL of LHS was higher (18.36 ± 0.15) compared to CCWP (9.32 ± 0.01), BCWP (8.33 ± 0.02) and BBTS (8.27 ± 0.09), SCCS (5.58 ± 0.38) and SC (4.96 ± 0.02) with the lowest eGL.

All in all, HI, eGI and eGL based on both reference foods showed similar trends in which all analysed food samples were significantly lower than both WB and glucose.

According to Huang and Miskelly (2016), foods having a high glycaemic index are rapidly digested, resulting in a rapid increase in blood glucose levels after consumption. The finding was consistent with the initial increased rate of HI at 30 minutes for SCSS (27.56% starch/min) and LHS (28.20% starch/min). The rate of starch hydrolysis reflects these samples having high total starch content (**Table 2**) and high eGI (**Table 3**). However, other contributing factors also influenced starch hydrolysis, as explained above. The use of different reference foods may influence the outcome of GI values. Venn et al. (2014) stated that a standard such as white bread is more relevant when evaluating the glycaemic response to food containing carbohydrates. Different glycaemic levels were observed when testing starchy foods compared to using a glucose beverage as the reference. The use of glucose as a reference for sugary foods may be acceptable, and it is a good indicator for sugary foods than starchy foods (Venn et al., 2014).

Based on the International Table of GI and GL values (Foster-Powell et al., 2002), mainly *in vivo* studies of canned food products with solid-based properties used white bread as the reference food. Meanwhile, the reported canned lychee and sweetened condensed milk use glucose as the reference food because of their liquid-based properties. Thus, corresponding to the analysed food samples in this study, glucose applies to this study's reference food. It is due to the physical form of the studied food samples consisting mainly of non-solid and sugar foods. Besides, the data of GI and GL are approximately consistent with those found *in vivo* studies. The GI values between the analysed and reported food samples showed a slight difference compared with glucose as a reference food. The eGI of BBTS has three units lower than the GI values of reported BBTS. Meanwhile, SC and LHS had lower GI values compared to their reported SC and lychee with 20 units and 22 units, respectively.

4.4 Comparison of eGI₂ and eGL₂ with the International Table of Glycaemic Index

Based on previous GI studies using the *in vivo* system (**Table 4**), the trends of GI for the reported foods showed higher values than the analysed food samples in this study. The reported glucose (GI=143) also had a higher GI than the analysed glucose (eGI=109.20 ± 1.16). For analysed food samples, reported BBTS showed a greater value (GI=56) than analysed BBTS (eGI= 53.72 ± 0.57), reported SC (GI=61) with analysed SC (eGI= 41.35 ± 0.10), and reported lychee (GI=79) with analysed LHS (eGI= 57.39 ± 0.46).

Based on the comparison GL with the International Table of GI and GL (Foster-Powell et al., 2002), the trends showed GL of reported foods had higher values than eGL. The serving sizes are calculated based on the equivalent serving size of reported foods to compare GL and eGL. The reported SC showed a higher value of GL (GL=83) than analysed SC (eGL=62). However, both of the values are within the category of high GL. Next, reported lychee had GL of 16, while analysed LHS had eGL of 15. Both values are classifying as medium GL. Thus, based on **Table 4**, different serving sizes might influence the GL values of similar types of foods.

Table 4. Comparison of eGI₂ and eGL₂ with the International Table of Glycaemic Index.

Sample	Serving size (g)	eGI ₂	eGL ₂	eGL ₂ (based on equivalent serving size)	International Table of Glycaemic Index ^a			
					GI	Serving Size (g)	Total Available Carbohydrate	GL
BBTS	106	53.72 ± 0.57 ^d	8.27 ± 0.09 ^e	NA	80	NA	NA	NA
SCCS	85	57.48 ± 0.41 ^c	5.58 ± 0.38 ^f	NA	NA	NA	NA	NA
SC	20	41.35 ± 0.10 ^f	4.96 ± 0.02 ^g	62	87	250	136	83
BCWP	285	41.66 ± 0.09 ^f	8.33 ± 0.02 ^e	NA	NA	NA	NA	NA
CCWP	300	44.37 ± 0.05 ^e	9.32 ± 0.01 ^d	NA	NA	NA	NA	NA
LHS	140	57.39 ± 0.46 ^c	18.36 ± 0.15 ^c	15	113	120	20	16

Note: Values are presented as mean ± standard deviation. Different superscripts (c, d, e, f, g) in the same column indicate that there are significant statistical differences between analysed food samples (ANOVA $p < 0.05$, Tukey's test).

eGI, eGL, GI and GL represent an estimated glycaemic index, estimated glycaemic load, glycaemic index and glycaemic load, respectively. Subscripts 2 for eGI and eGL represent glucose. GL values were classified as low (≤ 10), medium (11–19) and high (≥ 20), (Venn & Green, 2007)

^aThe values used glucose as the reference food.

Adapted from Foster-Powell et al., 2002.

Abbreviations: BBTS: baked beans in tomato sauce; SCCS: sweet corn cream style; SC: sweetened creamer; BCWP: beef curry with potatoes; CCWP: chicken curry with potatoes; LHS: lychee in heavy syrup; NA: not available.

The varied values showed in **Table 4** between the GI of analysed food samples with reported foods may be attributed to the different compositions of the canned foods. A study found that the metal used in canning may include heavy metals (Solidum, 2013). A range of metals are naturally found on Earth's surface, and some of these, such as lead, cadmium, silver, mercury, and arsenic, may affect the human body even in trace amounts. Heavy metals are hazardous even at low concentrations and tend to bio-accumulate owing to biodegradability resistance (Solidum, 2013).

Based on the study, Solidum (2013) found that one of the peach sample syrup had detectable amounts of cadmium, while the others indicated below the limit of detection of the instrument at 0.05ppm (parts per million). Cadmium is toxic that may cause damage to many internal organs, including the brain, heart, blood vessels, kidneys, and lungs (Solidum, 2013). Corresponding to that, a longitudinal study by Xiao et al. (2021) revealed that individuals with high cadmium exposure had a substantial rise in fasting blood glucose levels at follow up for over three years. Nevertheless, chronic cadmium exposure was linked to an elevated incidence of incident T2DM, although not significantly. There is no significant relationship due to the slow progression of diabetes and the limited duration of the follow-ups of the study. Hence, Xiao et al. (2021) recommend further studies with longer follow-ups to study the association.

Moreover, Foster-Powell et al. (2000) explained that the variation of GI values in the same types of food could be due to methodological factors and variations in the physical and chemical properties of the foods. Another reason is that similar types of foods may contain different components or had been prepared using a different technique, and as a result, the GI value differs substantially. Based on the GI values of analysed and reported food samples, the GI values differ due to different preparation methods. For example, the GI values of analysed LHS differ from reported lychee because the reported lychee had drained syrup during the sample preparation (Foster-Powell et al., 2000). While for analysed LHS, the sample undergoes homogenisation, including its heavy syrup during the sample preparation.

In addition, based on the current study, the analysed food samples underwent the freeze-drying process. It suggested that GI and GL variation may influence by different food composition and preparation processes between the analysed food samples and reported food. Relative to *in vivo* study, the drying process can affect the digestion rate (hydrolysis) of protein, reducing the protein size (Manullang et al., 2020). Thus, it led to an increase in the protein hydrolysis process by the protease enzyme and made the digestion process more accessible. The process could explain the differences in the GI values of analysed and reported food samples.

4.5 Correlation between Estimated Glycaemic Index (eGI) with Estimated Glycaemic Load (eGL), Analysed Total Available Carbohydrate and Fat Content.

Bivariate Pearson's correlation was conducted to analyse the association between estimated glycaemic index (eGI) with estimated glycaemic load (eGL), analysed total available carbohydrate and fat content (**Table 5**).

Table 5. Association between estimated glycaemic index (eGI) with estimated glycaemic load (eGL), analysed total available carbohydrate and fat content of food samples.

Nutrient composition	eGI ₂	
	<i>r</i>	<i>p-value</i>
eGL ₂	0.430	0.075
Total available carbohydrate (%) ¹ (n=18)	0.167	0.508
Fat content (%) ² (n=9)	0.721*	0.028

Note: eGI and eGL represent estimated glycaemic index and estimated glycaemic load, respectively. Subscripts 2 for eGI represent glucose. Where, superscript 1 and 2 indicates the values based on wet and dry-basis weight, respectively.

*Correlation is significant at the 0.05 level (2-tailed).

4.5.1 Correlation between estimated glycaemic index (eGI) with estimated glycaemic load (eGL).

Using glucose as a reference food, the association between eGI and eGL showed no significant correlation ($r(18) = 0.430, p = 0.075$). The finding was contradictory with the previous studies that stated that consuming food with low GI and GL rates cause slow elevation of blood glucose levels (Jafar & Indriasari, 2014). In addition, Mentado and Pérez (2019) found that diets in their studies had low GI by reducing the GL of the individual foods. Furthermore, diets with a lower GL, such as higher protein/moderate carbohydrate (Larsen et al., 2010), Mediterranean diets (Shai et al., 2008), and low GI diets (McMillan-Price et al., 2006), have been associated with better weight management and risk factors for T2DM and CVD in randomised controlled studies. Even so, Venn et al. (2007) found mixed findings of the relationship between GI and GL. The correlation between GI and GL is not clear. [For example, if eaten in moderation, a high GI food may have a low GL]. The study also found that watermelon, a high GI food (GI=72), has the same GL value (GL=4) as high fat ice cream (GI=37). Besides, they also found that mashed potato, a high GI food (GI=74), has a low GL value (GL=15) compared to macaroni, a low GI food (GI=47) that has a high GL (23). Hence, these findings showed that the correlation of GI and GL is not straightforward.

4.5.2 Correlation between estimated glycaemic index (eGI) with analysed total available carbohydrate content.

Based on the reference food of glucose, there was no significant correlation between eGI and total available carbohydrate content ($r(18) = 0.167$, $p = 0.508$). There were mixed findings of GI and total available carbohydrate content. A study done by Zurbau et al. (2018) reported the influences of available carbohydrates on GI values. They examined the carbohydrate source of four meals included chickpeas (GI = 28, GL = 14, 50 g available carbohydrates (CHO)), a small potato portion (GI = 85, GL = 14, CHO = 17 g), pasta (GI = 45, GL = 42, CHO = 94 g), or a big potato portion (GI = 85, GL = 42, CHO = 50 g). The study outcome showed no significant correlation in GI values obtained with different portion sizes for any meals. Zurbau et al. (2018) concluded that, even though the carbohydrates were doubled, there was no change in glycaemic response between the big potato and pasta meals. Hence, the result emphasized that the amount of available carbohydrates does not influence the GI values.

It was corresponding to the previous study Aston et al. (2007) that examined the impact of utilising portions that vary in the proportion of available carbohydrate affecting result GI values. In order to compare the findings obtained, two of the bread (wholemeal and white bread) were analysed with both 25 and 50 g of available carbohydrate. There were no significant differences in the GI values for any of this bread when using various serving amounts. The result indicates that the available carbohydrate does not influence the GI values of the food.

Despite that, a study by Meng et al. (2017) used GI values of individual food to estimate the GI and GL of mixed meals with the same amount of available carbohydrate. Based on the

finding, as the number of available carbohydrates in the analysed food increased, thus did the *in vitro* and *in vivo* GI and GL values also increased. This finding suggests that meals using individual GI values match directly measured meal (mixed meals) GI and GL values. The association is unclear for GI and GL values of whole diets from daily food intake instead of at a time by using individual GI values. This study also recommends further research on this relationship because these findings may overestimate the actual effect, thus providing uncertainty regarding the prediction of meal GI and GL values.

4.5.3 Correlation between estimated glycaemic index (eGI) with analysed fat content.

In contrast to total available carbohydrates, there was a significant correlation between the eGI with the analysed fat content of food samples ($r(9) = 0.721, p = 0.028$). There were mixed findings based on the correlation between eGI with fat content. A case-cohort study conducted by Forouhi et al. (2014) found the inverse relationship between GI and fat content. The lower GI found after frying than roasting may be related to the high lipid content, which promotes a delayed rate of starch digestion due to the delay in stomach emptying. Indeed, lipids have shown to delay stomach emptying. In contrast, several studies on foods frequently eaten in the United Kingdom (Henry et al., 2005) and China (Chen et al., 2010) have shown that the amount of protein or fat in foods did not affect the glycaemic index (Al Dhaheri et al., 2015).

Besides, protein and carbohydrates also found to influence the GI. There were mixed findings based on *in vivo* studies of the correlation between eGI with carbohydrate content. The current study's findings, consistent with a Raczkowska and Bienkiewicz (2015) study, showed a significant correlation between GI and carbohydrate content. The GI showed a significant positive correlation with the carbohydrate content ($r = 0.410$) with $p < 0.05$. In addition, they also discovered that the addition of protein and fat in the dish led to reducing the GI of the dishes.

Corresponding to that, a study by Al Dhaheri et al. (2017) reported that the high protein content in Biryani (11.55 g/100 g) along with added vegetables (onion, garlic and pepper) could explain its low GI. The study was contradictory to studies done by Kouamé et al. (2017). Kouamé and colleagues reported in their finding that the GI of certain plantain-based street meals showed a significant inverse relationship between GI and total carbohydrate content. Still, no correlation between GI and protein content in the foods studied. Nevertheless, we could not analyse the correlation between protein and eGI in this current study due to time constraints.

CHAPTER 5

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

5.1 Conclusions

Today, the health aspect concerns a high glycaemic index (GI) diet relatable to food rich in carbohydrates and sugar content. Canned food is one of the foods that contain high nutrients such as sugar, fat, and carbohydrates. People have a high consumption of canned food due to its convenience, ease of travel, long-lasting and affordable to buy. This phenomenon needs to overcome to improve high-quality diets and prevent detrimental health effects due to less guidance of choosing healthier canned food. The *in vitro* study provides nutrient information focusing on GI values of canned foods limited by the market and research studies. Based on the market survey conducted, limited nutrient information was found, especially on GI values not provided by the manufacturer based on the Nutrition Information Panel of canned foods. The limitation provides less guidance and information for consumers to practice and makes a healthier food choice by considering the high and low GI diets.

This study determined the total available carbohydrate, total starch, fat, and moisture content in the analysed food samples. Findings showed that the amount of nutrients were significantly different among the canned foods. Food samples of BBTS (29.70 ± 0.16) have the highest total available carbohydrates. In contrast, LHS (7.86 ± 0.47) had the lowest value but no significant difference with BCWP (10.38 ± 0.83).

Food samples of LHS and SCCS with no significant difference reported the highest total starch content of 3083.49 g/100 g and 3252.89 g/100 g, respectively. However, LHS had (3083.49 g/100 g) no significant difference with BBTS (2838.65 g/100 g). Meanwhile, BCWP (739.03 g/100 g) and SC (687.53 g/100 g) had the lowest total starch content with no significant difference. Analysed fat content showed that CCWP (38.25 ± 2.93) significantly higher compared to BCWP (30.53 ± 2.58) and SC (0.43 ± 0.20). Lastly, the moisture content analysis found that LSH (85.05 ± 0.22) and SCCS (83.92 ± 0.78) had greater moisture content, with the lowest shown by SC (25.89 ± 0.31). The data obtained of the nutrient content can be an indicator for further analysis determination of the glycaemic index of canned foods.

The findings of this study on estimation of GI among the selected canned foods used glucose as a reference food. Overall, this study concluded that the analysed food samples of LHS and SCCS classified as medium GI food, and others (BBTS, SC, BCWP and CCWP) classified as low GI food. Meanwhile, the LHS classified as medium GL, and others (BBTS, SC, SCCS, BCWP and CCWP) classified as low GL food. The data obtained showed that canned SCCS and LHS had higher eGI with 57.48 ± 0.41 and 57.39 ± 0.46 . The lowest eGI obtained by BCWP (41.66 ± 0.09) and SC (41.35 ± 0.10) among the analysed canned food. The high values of eGL were reported among LHS (18.36 ± 0.15) and lowest by SC with $4.96 \pm$

0.02. Hence, the hypothesis of this study, as stated that the value of eGI and eGL of canned fruits is significantly higher than other selected canned foods, were accepted. This study also hypothesised a correlation between eGI with eGL and analysed total available carbohydrate and fat content. However, the hypothesis accepted the correlation between eGI and the analysed fat content of the selected canned foods.

The correlation was computed using a bivariate Pearson correlation to determine any association between eGI with eGL, analysed total available carbohydrate and fat content. The findings reported no significant correlation between eGI and eGL ($r(18) = 0.430, p = 0.075$). However, there was no significant correlation between eGI and total available carbohydrate ($r(18) = 0.167, p = 0.508$). There were mixed findings based on previous studies on the association of total available carbohydrates with GI values. Last but not least, the correlation of eGI with analysed fat content indicates significant correlation ($r(9) = 0.721, p = 0.028$). Most *in vivo* studies found a negative correlation between GI and fat, which was proven based on the function of fat to reduce the GI values. Consequently, this study suggested doing further research on this correlation to ensure an opposite correlation.

The findings from this study able to contribute to data on GI and others analysed nutrients of the selected canned foods to database and research. This study provides data of GI on individual canned foods, which ease the researchers to compare similar individual canned foods. Previously, most of the researchers studied the determination of GI on mixed meals. The GI values from mixed meals cannot be compared directly with the individual GI foods. Thus, the GI obtained of the individual canned foods in this study may provide new data for them.

Next, this study can help broaden the research on the analysis of canned food *in vitro* GI. The data of GI obtained from this study can help other researchers to obtain the data related to selected canned foods as their reference. Besides, other researchers can broaden this *in vitro* study to provide more findings on the correlation between nutrients and GI. Also, researchers can do further research on canned foods which focusing on specific types of canned foods.

Moreover, the analysed nutrient of the selected canned foods in this study also helps strengthen the industry's need to conduct nutrients analysis of their canned food. This approach can help to improve their product concerning health aspects and consumer needs and preferences. Lastly, this study also can provide data for the Malaysian Food Composition Database on GI of canned food. Due to limited studies on GI canned foods in Malaysia, this study can provide data on GI and other analysed nutrient compositions.

5.2 Limitations and Recommendations

Based on the findings of this study, there are several recommendations for the public related to information on the glycaemic index. First of all, corresponding to the relation of GI and GL, the public should consider both intakes of GI with GL food. They should not only focus on consuming high or low GI food because the GL can also influence the GI response. Moreover, low GI food does not mean a good indicator for the healthy option. Hence, other nutrients available in the food also required to consider such as the composition of fat, protein, carbohydrates, fibre and other nutrients. For example, the public can choose canned food of beef curry with potatoes, which complement other nutrients (fat and protein) that can help reduce GI response. Overall, GI labelling is not suggested to provide on the food product. Due to this reason, GI labelling can lead to misleading information and misconception of the public. They tend to choose the food with low GI labelling without considering other nutrients that may affect the GI to increase or lower the GI response.

This study has some limitations that future researchers can consider to improve the findings of *in vitro* studies. Initially, this study determined GI on selected canned foods of different categories (fruits, vegetables, pulses, meat and poultry, and milk products). The determination of GI and other nutrients is not representative of all canned foods within each category. Thus, future research recommends focusing on a specific category of canned foods with different brands or types. Next, the conventional Soxhlet method used in this study to analyse fat content encountered some data errors. The errors may be due to the properties of the analysed food samples (sweetened creamer) not suitable for using the conventional Soxhlet method. Hence, future research suggests using other milk fat extraction such as the automated

Soxhlet, Folch, and Bligh and Dyer methods. In addition, the data provided by NIP cannot be used to analyse the correlation of nutrients with eGI because of the single data provided. Hence, it is suggested to conduct a nutrient analysis to correlate the food's nutrient content with the eGI.

Moreover, this study analysed the estimated glycaemic index (eGI) of individual foods, which are limited in the research field of *in vitro* studies. Therefore, it is recommended for future research to expand the *in vitro* studies of canned foods based on individual foods. Furthermore, due to the limited GI data for individual foods, most studies emphasised mixed meals. Therefore, it is very challenging to compare because the GI data of mixed meals cannot be compared directly with individuals as it may encounter some error. Besides, a study on individual food can help consumers choose canned food with a low GI.

Furthermore, this study did not research the resistant starch in canned food that can affect GI response. The determination of resistant starch in canned food may help discover types of canned food with high resistant starch to improve glycaemic response towards slow digestion and release of glucose in the body. Moreover, further research is advocate to be conducted *in vitro* and *in vivo* studies of canned foods. Besides, *in vitro* study is done as an alternative to *in vivo* method. Therefore, *in vitro* is essential to predict the potential of GI value. Thus it is done in product reformulation. However, *in vivo* studies are recommended because *in vivo* studies are more predictive; therefore, the analysed samples can provide more reliable GI data. Also, the study can analyse the correlation between obtained estimated and measured GI of the food samples. The analysis can help to provide more data on the GI values of canned foods.

Lastly, time constraints limiting this study from analysing other nutrients may affect GI values. This study encountered limited protein and total dietary fibre content because we could not complete the analysis further. Thus, further research or studies should consider studying the correlation of protein and fibre content with GI values.



REFERENCES

- Absar, N., Zaidul, I., Takigawa, S., Hashimoto, N., Matsuura-Endo, C., Yamauchi, H., & Noda, T. (2009). Enzymatic hydrolysis of potato starches containing different amounts of phosphorus. *Food Chemistry*, 112(1), 57-62.
<https://doi.org/10.1016/j.foodchem.2008.05.045>
- Anderson, I. H., Levine, A. S., & Levitt, M. D. (1981). Incomplete absorption of the carbohydrate in all-purpose wheat flour. *New England Journal of Medicine*, 304(15), 891-892. <https://doi.org/10.1056/nejm198104093041507>
- Araya, H., Contreras, P., Alviña, M., Vera, G., & Pak, N. (2002). A comparison between an *in vitro* method to determine carbohydrate digestion rate and the glycaemic response in young men. *European Journal of Clinical Nutrition*, 56(8), 735-739.
<https://doi.org/10.1038/sj.ejcn.1601386>
- Argyri, K., Athanasatou, A., Bouga, M., & Kapsokefalou, M. (2016). The potential of an *in vitro* digestion method for predicting glycaemic response of foods and meals. *Nutrients*, 8(4), 209. <https://doi.org/10.3390/nu8040209>
- Augustin, L., Franceschi, S., Jenkins, D., Kendall, C., & La Vecchia, C. (2002). Glycaemic index in chronic disease: A review. *European Journal of Clinical Nutrition*, 56(11), 1049-1071. <https://doi.org/10.1038/sj.ejcn.1601454>
- Augustin, L., Kendall, C., Jenkins, D., Willett, W., Astrup, A., Barclay, A., Björck, I., Brand-Miller, J., Brighenti, F., Buyken, A., Ceriello, A., La Vecchia, C., Livesey, G., Liu, S., Riccardi, G., Rizkalla, S., Sievenpiper, J., Trichopoulou, A., Wolever, T., ... Poli, A. (2015). Glycaemic index, glycaemic load and glycaemic response: An international scientific consensus summit from the international carbohydrate quality consortium

(ICQC). *Nutrition, Metabolism and Cardiovascular Diseases*, 25(9), 795-815.

<https://doi.org/10.1016/j.numecd.2015.05.005>

AOAC International. (2000). *Official Methods of Analysis of AOAC International*. Maryland, USA: AOAC International.

Atkinson, F. S., Foster-Powell, K., & Brand-Miller, J. C. (2008). International tables of glycaemic index and glycaemic load values: 2008. *Diabetes Care*, 31(12), 2281-2283. <https://doi.org/10.2337/dc08-1239>

Al Dhaheri, A. S., Al Ma'awali, A. K., Laleye, L. C., Washi, S. A., Jarrar, A. H., Al Meqbaali, F. T., Mohamad, M. N., & Masuadi, E. M. (2015). The effect of nutritional composition on the glycaemic index and glycaemic load values of selected Emirati foods. *BMC Nutrition*, 1(1). <https://doi.org/10.1186/2055-0928-1-4>

A. Jafar & R. Indriasari (2014). "Diet and blood sugar levels of type 2 DM patient," *Jurnal Media Kesehatan. Masyarakat. Indonesia.*, pp. 211–21.

Agama-Acevedo, E., Pacheco-Vargas, G., Gutierrez-Meraz, F., Tovar, J., & Bello- Perez, L. A. (2019). Dietary fibre content, texture, and *in vitro* starch digestibility of different white bread crusts. *Journal of Cereal Science*, 89.

Aston, L. M., Gambell, J. M., Lee, D. M., Bryant, S. P., & Jebb, S. A. (2008). Determination of the glycaemic index of various staple carbohydrate-rich foods in the UK diet. *European Journal of Clinical Nutrition*, 62(2), 279-285. <https://doi.org/10.1038/sj.ejcn.1602723>

- Al-Hamamre, Z., Foerster, S., Hartmann, F., Kröger, M., & Kaltschmitt, M. (2012). Oil extracted from spent coffee grounds as a renewable source for fatty acid methyl ester manufacturing. *Fuel*, 96, 70-76. <https://doi.org/10.1016/j.fuel.2012.01.023>
- Beitane, I., Kruma, Z., Kince, T., Sabovics, M., Iriste, S., Muizniece-Brasava, S., Bujaka, J., Strode, S., & Ciprovica, I. (2021). Case study: Free lunch meals provision during the remote learning conditions. *Nutrients*, 13(2), 605. <https://doi.org/10.3390/nu13020605>
- Brunt, K., Sanders, P., Nota, V. E., & Van Soest, J. (2020). Results multi-laboratory trial ISO/CD 22184 – IDF/WD 244: Milk and milk products – Determination of the sugar contents – High-performance anion exchange chromatography method with pulsed amperometric detection (HPAEC-PAD). *Journal of AOAC International*. <https://doi.org/10.1093/jaocint/qsaa092>
- Bao, J., Atkinson, F., Petocz, P., Willett, W. C., & Brand-Miller, J. C. (2011). Prediction of postprandial glycemia and insulinemia in lean, young, healthy adults: Glycaemic load compared with carbohydrate content alone. *The American Journal of Clinical Nutrition*, 93(5), 984-996. <https://doi.org/10.3945/ajcn.110.005033>
- Barclay, A. W., Petocz, P., McMillan-Price, J., Flood, V. M., Prvan, T., Mitchell, P., & Brand-Miller, J. C. (2008). Glycaemic index, glycaemic load, and chronic disease risk—a meta-analysis of observational studies. *The American Journal of Clinical Nutrition*, 87(3), 627-637. <https://doi.org/10.1093/ajcn/87.3.627>
- Brand-Miller, J. C. (2003). Glycaemic load and chronic disease. *Nutrition Reviews*, 61(suppl_5), S49-S55. <https://doi.org/10.1301/nr.2003.may.s49-s55>

- Brand-Miller, J., & Holt, S. (2004). Testing the glycaemic index of foods: In vivo, not in vitro. *European Journal of Clinical Nutrition*, 58(4), 700-701. <https://doi.org/10.1038/sj.ejcn.1601856>
- Brand-Miller. (2007). The glycaemic index as a measure of health and nutritional quality: An Australian perspective. *Cereal Foods World*. <https://doi.org/10.1094/cfw-52-2-0041>
- Brouns, F., Bjorck, I., Frayn, K. N., Gibbs, A. L., Lang, V., Slama, G., & Wolever, T. M. (2005). Glycaemic index methodology. *Nutrition Research Reviews*, 18(1), 145-171. <https://doi.org/10.1079/nrr2005100>
- Brownlee, M. (2001). Biochemistry and molecular cell biology of diabetic complications. *Nature*, 414(6865), 813-820. <https://doi.org/10.1038/414813a>
- Chepulis, L., Everson, N., Heapy, A., & Mearns, G. (2018). Added sugar and sodium levels in New Zealand processed fruit and vegetable-based products. *Nutrition and Dietetics*, 76(1), 67-74. <https://doi.org/10.1111/1747-0080.12470>
- Chenarides, L., Grebitus, C., Lusk, J. L., & Printezis, I. (2021). Food consumption behavior during the COVID-19 pandemic. *Agribusiness*, 37(1), 44-81.
- Chong, C. P., Haron, H., Shahar, S., & Md Noh, M. F. (2019). Individual sugars contents in cooked dishes, processed foods, fruits and beverages commonly consumed by Malaysian. *Journal of Food Composition and Analysis*, 80, 1-9. <https://doi.org/10.1016/j.jfca.2019.03.017>
- Chung, H., Liu, Q., Hoover, R., Warkentin, T. D., & Vandenberg, B. (2008). *in vitro* starch digestibility, expected glycaemic index, and thermal and pasting properties of flours from pea, lentil and chickpea cultivars. *Food Chemistry*, 111(2), 316-321. <https://doi.org/10.1016/j.foodchem.2008.03.062>

- Deepa, G., Singh, V., & Naidu, K. A. (2010). A comparative study on starch digestibility, glycaemic index and resistant starch of pigmented ('Njavara' and 'Jyothi') and a non-pigmented ('IR 64') rice varieties. *Journal of Food Science and Technology*, 47(6), 644-649. <https://doi.org/10.1007/s13197-010-0106-1>
- Dona, A. C., Pages, G., Gilbert, R. G., & Kuchel, P. W. (2010). Digestion of starch: In vivo and *in vitro* kinetic models used to characterise oligosaccharide or glucose release. *Carbohydrate Polymers*, 80(3), 599-617. <https://doi.org/10.1016/j.carbpol.2010.01.002>
- Dietary fibre (2015). British Nutrition Foundation. <https://www.nutrition.org.uk/nutritionscience/nutrients-food-and-ingredients/dietary-fibre.html>
- De Carvalho, C. M., De Paula, T. P., Viana, L. V., Machado, V. M., De Almeida, J. C., & Azevedo, M. J. (2017). Plasma glucose and insulin responses after consumption of breakfasts with different sources of soluble fibre in type 2 diabetes patients: A randomized crossover clinical trial. *The American Journal of Clinical Nutrition*, ajcn157263. <https://doi.org/10.3945/ajcn.117.157263>
- Englyst, H. (1987). Colorimetric method for routine measurement of dietary fibre as non-starch polysaccharides. A comparison with gas-liquid chromatography. *Food Chemistry*, 24(1), 63-76. [https://doi.org/10.1016/0308-8146\(87\)90084-7](https://doi.org/10.1016/0308-8146(87)90084-7)
- Emanuele, S., Lauricella, M., Calvaruso, G., D'Anneo, A., & Giuliano, M. (2017). Litchi chinensis as a functional food and a source of antitumor compounds: An overview and a description of biochemical pathways. *Nutrients*, 9(9), 992. <https://doi.org/10.3390/nu9090992>

Englyst, H. N., Kingmans, S. M., & Gummings, J.H. (1996). Classification and measurement of nutritionally important starch fraction. *European Journal of Clinical Nutrition*, 46, 335–505.

Eleazu, C. O. (2016). The concept of low glycaemic index and glycaemic load foods as Panacea for type 2 diabetes mellitus; prospects, challenges and solutions. *African Health Sciences*, 16(2), 468. <https://doi.org/10.4314/ahs.v16i2.15>

Fan, J., Song, Y., Wang, Y., Hui, R., & Zhang, W. (2012). Dietary glycaemic index, glycaemic load, and risk of coronary heart disease, stroke, and stroke mortality: A systematic review with meta-analysis. *PLoS ONE*, 7(12), e52182. <https://doi.org/10.1371/journal.pone.0052182>

Foster-Powell, K., Holt, S. H., & Brand-Miller, J. C. (2002). International table of glycaemic index and glycaemic load values: 2002. *The American Journal of Clinical Nutrition*, 76(1), 5-56. <https://doi.org/10.1093/ajcn/76.1.5>

Forouhi, N. G., Koulman, A., Sharp, S. J., Imamura, F., Kröger, J., Schulze, M. B., Crowe, F. L., Huerta, J. M., Guevara, M., Beulens, J. W. J., van Woudenberg, G. J., Wang, L., Summerhill, K., Griffin, J. L., Feskens, E. J. M., Amiano, P., Boeing, H., Clavel-Chapelon, F., Dartois, L., ... Wareham, N. J. (2014). Differences in the prospective association between individual plasma phospholipid saturated fatty acids and incident type 2 diabetes: The EPIC-InterAct case-cohort study. *The Lancet Diabetes and Endocrinology*, 2(10), 810–818. <https://doi.org/10.1016/S2213-8587>

Farinde, E. O., Obatolu, V. A., & Fasoyiro, S. B. (2017). Microbial, Nutritional and Sensory Qualities of Baked Cooked and Steamed Cooked Lima Beans. *American Journal of Food Science and Technology*, 5(4), 156–161. <https://doi.org/10.12691/ajfst-5-4-6>

- Fernández-García, E., Carvajal-Lérída, I., & Pérez-Gálvez, A. (2009). *In vitro* bioaccessibility assessment as a prediction tool of nutritional efficiency. *Nutrition Research*, 29(11), 751-760. <https://doi.org/10.1016/j.nutres.2009.09.016>
- Foschia, M., Peressini, D., Sensidoni, A., Brennan, M. A., & Brennan, C. S. (2015). Synergistic effect of different dietary fibres in pasta on *in vitro* starch digestion? *Food Chemistry*, 172, 245-250. <https://doi.org/10.1016/j.foodchem.2014.09.062>
- Frei, M., Siddhuraju, P., & Becker, K. (2003). Studies on the *in vitro* starch digestibility and the glycaemic index of six different Indigenous rice cultivars from the Philippines. *Food Chemistry*, 83(3), 395-402. [https://doi.org/10.1016/s0308-8146\(03\)00101-8](https://doi.org/10.1016/s0308-8146(03)00101-8)
- Fuhrman, J. (2018). The hidden dangers of fast and processed food. *American Journal of Lifestyle Medicine*, 12(5), 375-381. <https://doi.org/10.1177/1559827618766483>
- FAO/WHO (1998). Carbohydrate in Human Nutrition. Report of a Joint Expert FAO/WHO Consultation. FAO Food and Nutrition Paper 66. Food and Agriculture Organization, Rome
- Featherstone, S. (2015). A complete course in Canning and related processes: Volume 3 processing procedures for canned food products. Woodhead Publishing.
- Gangwisch, J. E., Hale, L., Garcia, L., Malaspina, D., Opler, M. G., Payne, M. E., Rossom, R. C., & Lane, D. (2015). High glycaemic index diet as a risk factor for depression: Analyses from the women's health initiative. *The American Journal of Clinical Nutrition*, 102(2), 454-463. <https://doi.org/10.3945/ajcn.114.103846>
- Giugliano, D., Ceriello, A., & Esposito, K. (2008). Glucose metabolism and hyperglycemia. *The American Journal of Clinical Nutrition*, 87(1), 217S-222S. <https://doi.org/10.1093/ajcn/87.1.217s>

Glycaemic Index Foundation. (2017). *What affects the GI value?*

<https://www.gisymbol.com/what-affects-the-gi-value/>

Goñi, I., Garcia-Alonso, A., & Saura-Calixto, F. (1997). A starch hydrolysis procedure to estimate glycaemic index. *Nutrition Research*, 17(3), 427-437.

[https://doi.org/10.1016/s0271-5317\(97\)00010-9](https://doi.org/10.1016/s0271-5317(97)00010-9)

Graça, C., Raymundo, A., & Sousa, I. D. (2021). Yoghurt and curd cheese addition to wheat bread dough: Impact on *in vitro* starch digestibility and estimated glycaemic index. *Food Chemistry*, 339, 127887. <https://doi.org/10.1016/j.foodchem.2020.127887>

Greenwood, D. C., Threapleton, D. E., Evans, C. E., Cleghorn, C. L., Nykjaer, C., Woodhead, C., & Burley, V. J. (2013). Glycaemic index, glycaemic load, carbohydrates, and type 2 diabetes: Systematic review and dose-response meta-analysis of prospective studies. *Diabetes Care*, 36(12), 4166-4171. <https://doi.org/10.2337/dc13-0325>

Gourineni, V., Stewart, M., Skorge, R., & Sekula, B. (2017). Slowly digestible carbohydrate for balanced energy: *in vitro* and *in vivo* evidence. *Nutrients*, 9(11), 1230. <https://doi.org/10.3390/nu9111230>

Hettiaratchi, U. P. K., Ekanayake, S. and Welihinda, J. (2009) ‘Do Sri Lankan meals help decrease blood glucose response?’, *The Ceylon medical journal*, 54(2), pp.39–43.

Hajare, S. N., Saxena, S., Kumar, S., Wadhawan, S., More, V., Mishra, B., Narayan Parte, M., Gautam, S., & Sharma, A. (2010). Quality profile of litchi (*Litchi chinensis*) cultivars from India and effect of radiation processing. *Radiation Physics and Chemistry*, 79(9), 994-1004. <https://doi.org/10.1016/j.radphyschem.2010.03.014>

- Hewavitharana, G. G., Perera, D. N., Navaratne, S., & Wickramasinghe, I. (2020). Extraction methods of fat from food samples and preparation of fatty acid methyl esters for gas chromatography: A review. *Arabian Journal of Chemistry*, 13(8), 6865-6875.
<https://doi.org/10.1016/j.arabjc.2020.06.039>
- Huang, S., & Miskelly, D. (2016). Nutrition of Steamed Products. *Steamed Breads*, 161–168.
<https://doi.org/10.1016/b978-0-08-100715-0.00012-4>
- Halton, T. L., Willett, W. C., Liu, S., Manson, J. E., Albert, C. M., Rexrode, K., & Hu, F. B. (2006). Low-carbohydrate-Diet score and the risk of coronary heart disease in women. *New England Journal of Medicine*, 355(19), 1991-2002.
<https://doi.org/10.1056/nejmoa055317>
- Howlett, J., & Ashwell, M. (2008). Glycaemic response and health: Summary of a workshop. *The American Journal of Clinical Nutrition*, 87(1), 212S-216S.
<https://doi.org/10.1093/ajcn/87.1.212s>
- ISO 26642:2010. (2010). Determination of the glycaemic index (GI) and recommendation for food classification. Food Products. <https://www.iso.org/obp/ui/#iso:std:iso:26642:ed-1:v1:en>
- Institute for Public Health (2020). *National Health and Morbidity Survey 2019*. National Institutes of Health, Ministry of Health Malaysia.
- Jenkins, D. J., Thorne, M. J., Wolever, T. M., Jenkins, A. L., Rao, A. V., & Thompson, L. U. (1987). The effect of starch-protein interaction in wheat on the glycaemic response and rate of *in vitro* digestion. *The American Journal of Clinical Nutrition*, 45(5), 946-951.
<https://doi.org/10.1093/ajcn/45.5.946>

- Jenkins, D. J., Dehghan, M., Mente, A., Bangdiwala, S. I., Rangarajan, S., Srichaikul, K., ... & Yusuf, S. (2021). Glycemic Index, glycemic load, and cardiovascular disease and mortality. *New England Journal of Medicine*, 384(14), 1312-1322.
- Jenkins, D. J., Wolever, T. M., Taylor, R. H., Barker, H., Fielden, H., Baldwin, J. M., Bowling, A. C., Newman, H. C., Jenkins, A. L., & Goff, D. V. (1981). Glycaemic index of foods: A physiological basis for carbohydrate exchange. *The American Journal of Clinical Nutrition*, 34(3), 362-366. <https://doi.org/10.1093/ajcn/34.3.362>
- Jenkins. (2007). The glycaemic index: Looking back 25 years. *Cereal Foods World*. <https://doi.org/10.1094/cfw-52-1-0050>
- Jafari, S., Jouki, M., & Soltani, M. (2021). Modification of physicochemical, structural, rheological, and organoleptic properties of sweetened condensed milk by maltodextrin, fructose, and lactose. *Journal of Food Measurement and Characterization*. <https://doi.org/10.1007/s11694-021-00976-w>
- Janssen, M., Chang, B. P., Hristov, H., Pravst, I., Profeta, A., & Millard, J. (2021). Changes in food consumption during the COVID-19 pandemic: analysis of consumer survey data from the first lockdown period in Denmark, Germany, and Slovenia. *Frontiers in nutrition*, 8, 60.
- Juanola-Falgarona, M., Salas-Salvadó, J., Ibarrola-Jurado, N., Rabassa-Soler, A., Díaz-López, A., Guasch-Ferré, M., Hernández-Alonso, P., Balanza, R., & Bulló, M. (2014). Effect of the glycaemic index of the diet on weight loss, modulation of satiety, inflammation, and other metabolic risk factors: A randomized controlled trial. *The American Journal of Clinical Nutrition*, 100(1), 27-35. <https://doi.org/10.3945/ajcn.113.081216>

- Kapica, C., & Weiss, W. (2012). Canned fruits, vegetables, beans and fish provide nutrients at a lower cost compared to fresh, frozen or dried. *Journal of Nutrition and Food Sciences*, 02(04). <https://doi.org/10.4172/2155-9600.1000131>
- Kodi, C. T., & Seaquist, E. R. (2008). Cognitive dysfunction and diabetes mellitus. *Endocrine Reviews*, 29(4), 494-511. <https://doi.org/10.1210/er.2007-0034>
- Kumar, A., Basana Gowda, G., Sah, R. P., Sahu, C., Biswal, M., Nayak, S., Kumar, S., Swain, P., & Sharma, S. (2020). Status of glycaemic index of Paddy rice grain (*Oryza sativa* L.) on infestation by storage pest *Sitotroga cerealella*. *Journal of Stored Products Research*, 89, 101697. <https://doi.org/10.1016/j.jspr.2020.101697>
- Kouamé, C., Kouassi, N., Abodo, J., Pereko, K., Casiraghi, M., N'dri, D., & Amani, G. (2017). Glycaemic responses, glycaemic index, and glycaemic load values of some street foods prepared from plantain (*Musa* spp., AAB genome) in Cote d'Ivoire. *Foods*, 6(9), 83. <https://doi.org/10.3390/foods6090083>
- Lal, M. K., Kumar, A., Raigond, P., Dutt, S., Changan, S. S., Chourasia, K. N., Tiwari, R. K., Kumar, D., Sharma, S., Chakrabarti, S. K., & Singh, B. (2020). Impact of starch storage condition on glycaemic index and resistant starch of cooked potato (*solanum tuberosum*) tubers. *Starch – Stärke*, 73(1-2), 1900281. <https://doi.org/10.1002/star.201900281>
- Larsen, T. M., Dalskov, S., Van Baak, M., Jebb, S. A., Papadaki, A., Pfeiffer, A. F., Martinez, J. A., Handjieva-Darlenska, T., Kunešová, M., Pihlsgård, M., Stender, S., Holst, C., Saris, W. H., & Astrup, A. (2010). Diets with high or low protein content and glycaemic index for weight-loss maintenance. *New England Journal of Medicine*, 363(22), 2102-2113. <https://doi.org/10.1056/nejmoa1007137>

- Lesten, E. C., & Kingsley, M. (2019). The influence of solvents polarity on physicochemical properties and oil yield extracted from pumpkin (*Cucurbita maxima*) seed. *Journal of Agricultural Biotechnology and Sustainable Development*, 11(3), 40-47.
<https://doi.org/10.5897/jabsd2019.0354>
- Lumanlan, J. C., Fernando, W. M. A. D. B., Karnpanit, W., & Jayasena, V. (2021). Effects of food gums and pre-drying on fat content of fabricated fried chips. *International Journal of Food Science and Technology*, 56(4), 1544–1550.
<https://doi.org/10.1111/ijfs.14763>
- Lal, M. K., Kumar, A., Raigond, P., Dutt, S., Changan, S. S., Chourasia, K. N., Tiwari, R. K., Kumar, D., Sharma, S., Chakrabarti, S. K., & Singh, B. (2020). Impact of starch storage condition on glycaemic index and resistant starch of cooked potato (*solanumtuberosum*) tubers. *Starch-Stärke*, 73(1-2).
<https://doi.org/10.1002/star.201900281>
- Li, C. (2017). The role of beef in human nutrition and health. *Ensuring safety and quality in the production of beef Volume 2*, 329-338.
<https://www.researchgate.net/publication/317298356> The role of beef in human nutrition and health
- Lehmann, U., & Robin, F. (2007). Slowly digestible starch – its structure and health implications: A review. *Trends in Food Science and Technology*, 18(7), 346-355.
<https://doi.org/10.1016/j.tifs.2007.02.009>

- Lehmann, U., & Robin, F. (2007). Slowly digestible starch – its structure and health implications: A review. *Trends in Food Science and Technology*, 18(7), 346-355.
<https://doi.org/10.1016/j.tifs.2007.02.009>
- Liljeberg, H., Granfeldt, Y., & Björck, I. (1994). Metabolic responses to starch in bread containing intact kernels vs milled flour. *The American Journal of Clinical Nutrition*, 59(3), 779S-779S. <https://doi.org/10.1093/ajcn/59.3.779s>
- Livesey, G., Taylor, R., Hulshof, T., & Howlett, J. (2008). Glycaemic response and health—a systematic review and meta-analysis: The database, study characteristics, and macronutrient intakes. *The American Journal of Clinical Nutrition*, 87(1), 223S-236S.
<https://doi.org/10.1093/ajcn/87.1.223s>
- Lynch, D. R., Liu, Q., Tarn, T. R., Bizimungu, B., Chen, Q., Harris, P., Chik, C. L., & Skjold, N. M. (2007). Glycemic index — a review and implications for the potato industry. *American Journal of Potato Research*, 84(2), 179-190.
<https://doi.org/10.1007/bf02987141>
- Lobos, D. R., Vicuña, I. A., Novik, V., & Vega, C. A. (2017). Effect of high and low glycaemic index breakfast on postprandial metabolic parameters and satiety in subjects with type 2 diabetes mellitus under intensive insulin therapy: Controlled clinical trial. *Clinical Nutrition ESPEN*, 20, 12-16.
<https://doi.org/10.1016/j.clnesp.2017.04.082>
- Mirrahimi, A., De Souza, R. J., Chiavaroli, L., Sievenpiper, J. L., Beyene, J., Hanley, A. J., Augustin, L. S., Kendall, C. W., & Jenkins, D. J. (2012). Associations of glycaemic index and load with coronary heart disease events: A systematic review and meta-analysis of prospective cohorts. *Journal of the American Heart Association*, 1(5).
<https://doi.org/10.1161/jaha.112.000752>

- Monro, J. A. (2000). Evidence-based food choice: The need for new measures of food effects. *Trends in Food Science and Technology*, 11(4-5), 136-144. [https://doi.org/10.1016/s0924-2244\(00\)00041-8](https://doi.org/10.1016/s0924-2244(00)00041-8)
- Möller, K., Willers, J., Schneider, I., & Hahn, A. (2015). Glycaemic index and glycaemic load of a carbohydrate-rich and protein-rich formula diet. *Journal of Nutrition and Health sciences*, 2(4). <https://doi.org/10.15744/2393-9060.2.404>
- Manullang, V. A., Rahadiyanti, A., Pratiwi, S. N., & Afifah, D. N. (2020). Glycaemic index, starch, and protein digestibility in tempeh Gembus cookies. *Journal of Food Quality*, 2020, 1-6. <https://doi.org/10.1155/2020/5903109>
- McMillan-Price, J., Petocz, P., Atkinson, F., O'Neill, K., Samman, S., Steinbeck, K., Caterson, I., & Brand-Miller, J. (2006). Comparison of 4 Diets of Varying Glycaemic Load on Weight Loss and Cardiovascular Risk Reduction in Overweight and Obese Young Adults: A Randomized Controlled Trial. *Archives of Internal Medicine*, 166(14), 1466–1475. <https://doi.org/10.1001/archinte.166.14.1466>
- Meng, H., Matthan, N. R., Ausman, L. M., & Lichtenstein, A. H. (2017). Effect of macronutrients and fibre on postprandial glycaemic responses and meal glycaemic index and glycaemic load value determinations. *The American Journal of Clinical Nutrition*, 105(4), 842-853. <https://doi.org/10.3945/ajcn.116.144162>
- McCleary, B. V., McLoughlin, C., Charmier, L. M., & McGeough, P. (2019). Measurement of available carbohydrates, digestible, and resistant starch in food ingredients and products. *Cereal Chemistry*, 97(1), 114-137. <https://doi.org/10.1002/cche.10208>

- Mohideen, M. (2021). Review on extraction methods of essential oil from kaffir lime (*Citrus hystrix*) leaves. *Journal of Academia*, 9(1), 173-184. Retrieved from <http://myjms.mohe.gov.my/index.php/joa/article/view/11229>
- Mancini, A., Imperlini, E., Nigro, E., Montagnese, C., Daniele, A., Orrù, S., & Buono, P. (2015). Biological and nutritional properties of palm oil and palmitic acid: Effects on health. *Molecules*, 20(9), 17339-17361. <https://doi.org/10.3390/molecules200917339>
- Munira, Padil, Sarto, & Hidayat, M. (2018). Inhibitor effect (Lipid and protein) in starch hydrolysis to produce glucose by using Amyloglucosidase. *IOP Conference Series: Earth and Environmental Science*, 175, 012022. <https://doi.org/10.1088/1755-1315/175/1/012022>
- Mentado, M. N., & Pérez, E. S. (2019). Low glycaemic index diets for subjects with diabetes by minimizing glycaemic load of individual foods. *International Journal of Privacy and Health Information Management*, 7(1), 1-17. <https://doi.org/10.4018/ijphim.2019010101>
- National Center for Home Food Preservation. (2018). *Selecting, preparing and canning fruits : Syrups for canning fruits*. https://nchfp.uga.edu/how/can_02/syrups.html
- Nielsen, S. S. (2017). Introduction to food analysis. In *Food analysis* (pp. 3-16). Springer, Cham.
- Noda, T., Takigawa, S., Matsuura-Endo, C., Suzuki, T., Hashimoto, N., Kottarachchi, N., Yamauchi, H., & Zaidul, I. (2008). Factors affecting the digestibility of raw and gelatinized potato starches. *Food Chemistry*, 110(2), 465-470. <https://doi.org/10.1016/j.foodchem.2008.02.027>

National Health Service. (2018). *Eating processed foods*.

<https://www.nhs.uk/live-well/eat-well/what-are-processed-foods/>

Özcan, M. M., Ghafoor, K., Al Juhaimi, F., Uslu, N., Babiker, E. E., Mohamed Ahmed, I. A., & Almusallam, I. A. (2020). Influence of drying techniques on bioactive properties, phenolic compounds and fatty acid compositions of dried lemon and orange peel powders. *Journal of Food Science and Technology*, 58(1), 147-158.

<https://doi.org/10.1007/s13197-020-04524-0>

Pe´rez-Palacios, T., Ruiz, J., Martı´n, D., Muriel, E., Antequera, T., (2018). Comparison of different methods for total lipid quantification in meat and meat products. *Food Chem.* 110 (4), 1025–1029.

Peris-Tortajada. (2004). Carbohydrates and starch. In Leo M. L. N. (Eds.), *Handbook of food analysis: Physical characterization and nutrient analysis*, (pp.392). USA: Marcel Dekker, Inc.

Raczkowska, E., & Bienkiewicz, M. (2015). Effect of modifying recipes of dishes made of yeast dough on values of their glycaemic indices. *Journal of Food Processing and Technology*, 6(12). <https://doi.org/10.4172/2157-7110.1000531>

Recommended Nutrient Intakes for Malaysia (2017). National Coordinating Committee on Food and Nutrition (NCCFN), Ministry of Health Malaysia.

Rehm, C. D., Monsivais, P., & Drewnowski, A. (2011). The quality and monetary value of diets consumed by adults in the United States. *The American Journal of Clinical Nutrition*, 94(5), 1333-1339. <https://doi.org/10.3945/ajcn.111.015560>

Ren, X., Chen, J., Molla, M. M., Wang, C., Diao, X., & Shen, Q. (2016). *In vitro* starch digestibility and in vivo glycaemic response of foxtail millet and its products. *Food and Function*, 7(1), 372-379. <https://doi.org/10.1039/c5fo01074h>

Ringuette, C., Finley, J., Prinyawiwatkul, W., & King, J. M. (2017). Market surveys to determine availability of reduced glycaemic load/High fibre products. *Journal of Culinary Science and Technology*, 17(1), 9-21.

<https://doi.org/10.1080/15428052.2017.1399951>

Roberts, R. O., Roberts, L. A., Geda, Y. E., Cha, R. H., Pankratz, V. S., O'Connor, H. M., Knopman, D. S., & Petersen, R. C. (2012). Relative intake of macronutrients impacts risk of mild cognitive impairment or dementia. *Journal of Alzheimer's Disease*, 32(2), 329-339. <https://doi.org/10.3233/jad-2012-120862>

Ross, S. W., Brand, J. C., Thorburn, A. W., & Truswell, A. S. (1987). Glycaemic index of processed wheat products. *The American Journal of Clinical Nutrition*, 46(4), 631-635. <https://doi.org/10.1093/ajcn/46.4.631>

Seetharaman, S. (2016). The influences of dietary sugar and related metabolic disorders on cognitive aging and dementia. *Molecular Basis of Nutrition and Aging*, 331-344. <https://doi.org/10.1016/b978-0-12-801816-3.00024-8>

Seetharaman, S., Andel, R., McEvoy, C., Dahl Aslan, A. K., Finkel, D., & Pedersen, N. L. (2014). Blood glucose, diet-based glycaemic load and cognitive aging among dementia-free older adults. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 70(4), 471-479. <https://doi.org/10.1093/gerona/glu135>

Shan, Y. (2016). Canned citrus processing. *Canned Citrus Processing*, 7-46. <https://doi.org/10.1016/b978-0-12-804701-9.00002-2>

Sommerfield, A. J., Deary, I. J., & Frier, B. M. (2004). Acute hyperglycemia alters mood state and impairs cognitive performance in people with type 2 diabetes. *Diabetes Care*, 27(10), 2335-2340. <https://doi.org/10.2337/diacare.27.10.2335>

Sánchez-Villegas, A., Toledo, E., De Irala, J., Ruiz-Canela, M., Pla-Vidal, J., & Martínez-González, M. A. (2011). Fast-food and commercial baked goods consumption and the risk of depression. *Public Health Nutrition*, 15(3), 424-432.

<https://doi.org/10.1017/s1368980011001856>

Salmeron, J., Ascherio, A., Rimm, E. B., Colditz, G. A., Spiegelman, D., Jenkins, D. J., Stampfer, M. J., Wing, A. L., & Willett, W. C. (1997). Dietary fibre, glycaemic load, and risk of NIDDM in men. *Diabetes Care*, 20(4), 545-550.

<https://doi.org/10.2337/diacare.20.4.545>

Shai, I., Schwarzfuchs, D., Henkin, Y., Shahar, D. R., Witkow, S., Greenberg, I., Golan, R., Fraser, D., Bolotin, A., Vardi, H., Tangi-Rozental, O., Zuk-Ramot, R., Sarusi, B., Brickner, D., Schwartz, Z., Marko, R., Katorza, E., Thiery, J., Fiedler, G. M., ... Abra, D. (2008). *New England Journal of Medicine*, 3(10), 229–270.

<https://doi.org/10.1056/NEJMoa0708681>

Solidum, J.N. (2013). Heavy Metal Concentrations in Canned Fruits of Litchi chinensis, Prunus persica, and Ananas comosus Marketed in the Philippines. *Advanced Materials Research*, 634-638, 1570 - 1573.

Schönfeldt, H., & Gibson Hall, N. (2012). Dietary protein quality and malnutrition in Africa. *British Journal of Nutrition*, 108(S2), S69-S76.

<https://doi.org/10.1017/S0007114512002553>

Tessema, M., Gunaratna, N., Brouwer, I., Donato, K., Cohen, J., McConnell, M., Belachew, T., Belayneh, D., & De Groote, H. (2018). Associations among high-quality protein and energy intake, serum Transthyretin, serum amino acids and linear growth of children in Ethiopia. *Nutrients*, 10(11), 1776. <https://doi.org/10.3390/nu10111776>

- Tang, M., Wang, L., Cheng, X., Wu, Y., & Ouyang, J. (2019). Non-starch constituents influence the *in vitro* digestibility of naked oat (*Avena nuda* L.) starch. *Food Chemistry*, 297, 124953. <https://doi.org/10.1016/j.foodchem.2019.124953>
- Toh, D. W., Koh, E. S., & Kim, J. E. (2020). Lowering breakfast glycaemic index and glycaemic load attenuates postprandial glycaemic response: A systematically searched meta-analysis of randomized controlled trials. *Nutrition*, 71, 110634. <https://doi.org/10.1016/j.nut.2019.110634>
- Uauy, R., Kurpad, A., Tano-Debrah, K., Otoo, G. E., Aaron, G. A., Toride, Y., & Ghosh, S. (2015). Role of protein and amino acids in infant and young child nutrition: Protein and amino acid needs and relationship with child growth. *Journal of Nutritional Science and Vitaminology*, 61(Supplement), S192-S194. <https://doi.org/10.3177/jnsv.61.s192>
- Venn, B. J., & Green, T. J. (2007). Glycaemic index and glycaemic load: Measurement issues and their effect on diet–disease relationships. *European Journal of Clinical Nutrition*, 61(S1), S122-S131. <https://doi.org/10.1038/sj.ejcn.1602942>
- Venn, B. J., Kataoka, M., & Mann, J. (2014). The use of different reference foods in determining the glycaemic index of starchy and non-starchy test foods. *Nutrition Journal*, 13(1). <https://doi.org/10.1186/1475-2891-13-50>
- Vergara-Balderas, F. (2016). Canning: Process of Canning. *Encyclopedia of Food and Health*, 628-632. <https://doi.org/10.1016/b978-0-12-384947-2.00110-0>
- Vinoy, S., Meynier, A., Goux, A., Jourdan-Salloum, N., Normand, S., Rabasa-Lhoret, R., Brack, O., Nazare, J., Péronnet, F., & Laville, M. (2017). The effect of a breakfast rich in slowly digestible starch on glucose metabolism: A statistical meta-analysis of randomized controlled trials. *Nutrients*, 9(4), 318. <https://doi.org/10.3390/nu9040318>

- Webster, D., & Sollid, K. (2018). Is everyone really on a low-carbohydrate diet? Consumer perceptions of carbohydrates and sugars. *Cereal Foods World*.
<https://doi.org/10.1094/cfw-63-3-0116>
- Willett, W., Manson, J., & Liu, S. (2002). Glycaemic index, glycaemic load, and risk of type 2 diabetes. *The American Journal of Clinical Nutrition*, 76(1), 274S-280S.
<https://doi.org/10.1093/ajcn/76.1.274s>
- Woolnough, J. W., Monro, J. A., Brennan, C. S., & Bird, A. R. (2008). Simulating human carbohydrate digestion in vitro: A review of methods and the need for standardisation. *International Journal of Food Science and Technology*, 43(12), 2245-2256.
<https://doi.org/10.1111/j.1365-2621.2008.01862.x>
- Xiao, L., Li, W., Zhu, C., Yang, S., Zhou, M., Wang, B., Wang, X., Wang, D., Ma, J., Zhou, Y., & Chen, W. (2021). Cadmium exposure, fasting blood glucose changes, and type 2 diabetes mellitus: A longitudinal prospective study in China. *Environmental research*, 192, 110259. <https://doi.org/10.1016/j.envres.2020.110259>
- Yang, Z., Wang, T., Wang, H., Huang, X., Qin, Y., & Hu, G. (2013). Patterns of enzyme activities and gene expressions in sucrose metabolism in relation to sugar accumulation and composition in the aril of *Litchi chinensis* Sonn. *Journal of Plant Physiology*, 170, 731–740. <https://doi.org/10.1016/j.jplph.2012.12.021>
- Yang, Y., Jiao, A., Zhao, S., Liu, Q., Fu, X., & Jin, Z. (2021). Effect of removal of endogenous non-starch components on the structural, physicochemical properties, and *in vitro* digestibility of Highland Barley starch. *Food Hydrocolloids*, 117, 106698.
<https://doi.org/10.1016/j.foodhyd.2021.106698>

- Yu, W., Zou, W., Dhital, S., Wu, P., Gidley, M. J., Fox, G. P., et al. (2018). The adsorption of alpha-amylase on barley proteins affects the *in vitro* digestion of starch in barley flour. *Food Chemistry*, 241, 493–501.
- Zou, W., Sissons, M., Gidley, M. J., Gilbert, R. G., & Warren, F. J. (2015). Combined techniques for characterising pasta structure reveals how the gluten network slows enzymic digestion rate. *Food Chemistry*, 188, 559–568.
- Zurbau, A., Jenkins, A. L., Jovanovski, E., Au-Yeung, F., Bateman, E. A., Brissette, C., Wolever, T. M., Hanna, A., & Vuksan, V. (2018). Acute effect of equicaloric meals varying in glycaemic index and glycaemic load on arterial stiffness and glycemia in healthy adults: A randomized crossover trial. *European Journal of Clinical Nutrition*, 73(1), 79–85. <https://doi.org/10.1038/s41430-018-0182-2>
- Zimmet, P., Alberti, K. G., & Shaw, J. (2001). Global and societal implications of the diabetes epidemic. *Nature*, 414(6865), 782–787. <https://doi.org/10.1038/414782a>

APPENDICES

APPENDIX A



(a)



(b)

Figure 4 (a) (b): Available canned foods in the local market.

APPENDIX B

Figures showed six (6) samples based on the categories of selected canned foods with the nutrient content on NIP and a list of the ingredients.

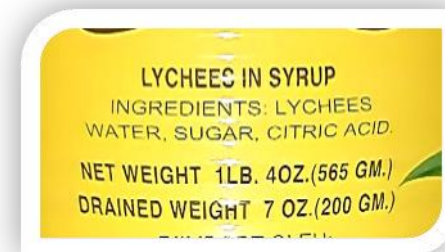
Category of canned food (Canned fruits): Lychee in heavy syrup (LHS)



(a)

Maklumat Nutrien Nutrition Information		
Saiz Hidangan / Serving size: 140g (with liquid)		
Hidangan Setiap Bungkusan / Serving per package: 4		
	Per 100 g	Per Serving (140 g)
Tenaga / Energy	93.5 kcal (393 kJ)	130 kcal (546 kJ)
Protein / Protein	0.6 g	0.8 g
Karbohidrat / Carbohydrate	22.8 g	32 g
Lemak / Fat	0 g	0 g
Jumlah Gula / Total Sugar	21.7 g	30 g

(b)



(c)

Figure 5: Pictures from left showed the front side of food product **(a)**, NIP **(b)** and list of the ingredients **(c)**.



Category of canned food (Canned vegetables): Sweet corn cream styles (SCCS)



(a)



(b)

Figure 6: Pictures from left showed the front side of food product (a) and NIP with list of the ingredients (b).

Category of canned food (Canned pulses): Baked beans in tomato sauce (BBTS).



(a)

KETERANGAN PEMAKANAN/NUTRITION INFORMATION		
Hidangan setiap pek / Servings per package: 4		
Saiz hidangan / Serving Size: 106g (1/4 can)		
Setiap hidangan/Per Serving (106g)	Per 100g	
Tenaga / Energy (1kcal=4.2kJ)	95kcal	90kcal
Protein / Protein	4.3g	4.1g
Lemak / Fat	0.5g	0.5g
Karbohidrat / Carbohydrate	15.4g	14.5g
Bahan-bahan: kacang, sos tomato [gula, pes tomato, mengandungi tepung kanji jagung sebagai kondisioner makanan yang dibenarkan, garam, cuka, campuran rempah (mengandungi maltodextrin sebagai kondisioner makanan yang dibenarkan, gula perang, serbuk bawang, serbuk bawang putih, minyak kanola, kayu manis)]. Ingredients: beans, tomato sauce [sugar, tomato paste, contains modified corn starch as permitted food conditioner, salt, vinegar, mixed spice seasoning (contains maltodextrins as permitted food conditioner, brown sugar, onion powder, garlic powder, canola oil, cinnamon)].		

(b)

Figure 7: Pictures from left showed the front side of food product (a) and NIP with list of the ingredients (b).

APPENDIX B

Category of canned food (Canned meat and poultry): Beef curry with potatoes (BCWP).



(a)

Nutrition Information / Maklumat Pemakanan		
Serving Size / Saiz Hidangan: 285g		
Serving Per Can / Hidangan Setiap Tin: 1		
	Per Serving Size Of 285g / Setiap Hidangan 285g	Per Serving Size Of 100g / Setiap Hidangan 100g
Energy / Tenaga	564 kcal	198 kcal
Protein	37g	13g
Carbohydrate / Karbhidrat	20g	7g
Fat / Lemak	37g	13g
Sodium	1157mg	406mg

(b)

RAMUAN: Daging Karbau, Ubi Kentang, Minyak Makan (Minyak Sawit), Rempah, Kelapa, Bawang, Garam & Bahan Pemekat E1414.
新星咖喱牛肉 配有马铃薯
INGREDIENTS: Buffalo Meat, Potatoes, Edible Oil (Palm Oil), Spices, Coconut, Onions, Salt & Thickener E1414
BERAT BERSIH / NET WEIGHT: 285g

(c)

Figure 8: Pictures from left showed the front side of food product (a), NIP (b) and list of the ingredients (c).

APPENDIX B

Category of canned food (Canned meat and poultry): Chicken curry with potatoes (CCWP).



(a)

Nutrition Information / Maklumat Pemakanan		
Serving Size / Saiz Hidangan: 300 g		
Serving Per Can / Hidangan Setiap Tin: 1		
	Per Serving Size Of 300g/ Setiap Hidangan 300g	Per Serving Size Of 100g/ Setiap Hidangan 100g
Energy / Tenaga	429 kcal	143 kcal
Protein	36g	12g
Carbohydrate / Karbhidrat	21g	7g
Fat / Lemak	24g	8g
Sodium	1431mg	477mg

(b)

RAMUAN: Daging Ayam, Ubi Kentang, Rempah, Bawang, Kelapa, Minyak Makan (Minyak Sawit), Garam & Bahan Pemekat E1414
新星咖喱雞 配有馬鈴薯
INGREDIENTS: Chicken, Potatoes, Spices, Onions, Coconuts, Edible Oil (Palm Oil), Salt & Thickener E1414.
BERAT BERSIH / NET WEIGHT: 300g

(c)

Figure 9: Pictures from left showed the front side of food product (a), NIP (b) and list of the ingredients (c).

APPENDIX B

Category of canned food (Canned milk product): Sweetened creamer (SC).



(a)

MAKLUMAT PEMAKANAN/ NUTRITION INFORMATION			
Bilangan Sajian / No. of Servings: 25			
		Setiap 100g Per 100g	Setiap Sajian (20g) Per Serving (20g)
Tenaga / Energy (kcal)		339	68
Protein	(g)	2	0.4
Lemak / Fat	(g)	10	2
Karbohidrat / Carbohydrate	(g)	60.2	12
Kolesterol / Cholesterol	(mg)	0	0
Vitamin A	(µg)	201	40
Vitamin D	(µg)	2.8	0.6
Vitamin B1	(mg)	0.82	0.16

(b)

Ramuan:
Gula, Pepejal Susu Tanpa Lemak, Minyak Kelapa Sawit yang Bertapis dan Vitamin-vitamin (B1, A & D). Mengandungi Kondisioner Makanan (Penstabil) yang Dibenarkan.
Ingredients:
Sugar, Non-Fat Milk Solids, Refined Palm Oil and Vitamins (B1, A & D). Contains Permitted Food Conditioner (Stabiliser).

(c)

Figure 10: Pictures from left showed the front side of food product (a), NIP (b) and list of the ingredients (c).

Summary report of Turnitin

