INTERVENTION PILOT STUDY: EFFECTS OF BREAKFAST OATDRINK CONSUMPTION ON BOWEL FUNCTION AND HEALTH PARAMETERS AMONG UTAR KAMPAR FEMALE UNIVERSITY STUDENTS

By

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ABSTRACT

INTERVENTION PILOT STUDY: EFFECTS OF BREAKFAST OATDRINK CONSUMPTION ON BOWEL FUNCTION AND HEALTH PARAMETERS AMONG UTAR KAMPAR FEMALE UNIVERSITY STUDENTS

Quah Hong Yi

Oat is claimed to promote several health benefits, which include promoting good bowel functions, promoting weight management, controlling blood glucose level, managing hypertension and reduce inflammation. However, there were contradictory results shown from the previous studies raises up the queries on how good actually the oat consumption on the bowel function and health parameters. Besides, there are lack of studies being out carried among the young adults from 18 – 25 years old and no studies related to this topic has been carried out in UTAR. Therefore, current study is aimed to investigate the effects of commercial oat drink (3 in 1) consumption on bowel function and general health among UTAR Kampar female university students. An intervention pilot study with a total of 26 participants was recruited and asked to consume a sachet of Quaker's 3 in 1 instant oat drink during the 14-days of intervention. Questionnaire, bowel diary and food diary were used to collect the data. All the data collected were analyzed by using

Microsoft Excel and SAS software. Chi-square test was used to test the discrete variables (bowel function) and paired T-test was used to test the continuous data (health parameters).Based on the results, our study gives an idea that oat drink consumption may relieve constipation, increase the risk of having diarrhea, better weight and glycemic management, increase blood pressure and no effects on the inflammation properties among UTAR Kampar female university students. Further studies which using large sample size, long duration and randomized controlled trial are suggested to be carried out to study the long-term effects of oat drink intervention on the bowel function and health parameters.

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Finally, I want to thank my family for helping me out financially so I could finish this course. My friends have been the ideal study companions. I want to take this opportunity to thank them for their constant inspiration and support.

DECLARATION

I hereby declare that this final year project report is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

QUAH HONG YI

APPROVAL SHEET

This final year project report entitled "**INTERVENTION PILOT STUDY: EFFECTS OF BREAKFAST OAT DRINK CONSUMPTION ON BOWEL FUNCTION AND HEALTH PARAMETERS AMONG UTAR KAMPAR FEMALE UNIVERSITY STUDENTS**" was prepared by QUAH HONG YI and submitted as partial fulfilment of the requirements for the degree of Bachelor of Science (Honours) Dietetics at Universiti Tunku Abdul Rahman.

Approved by:

(Dr. Tan Gim Cheong) Date: 14th September 2023

Supervisor

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PERMISSION SHEET

It is hereby certified that **QUAH HONG YI (ID No: 20ADB05582)** has completed this final year project report entitled **"INTERVENTION PILOT STUDY: EFFECTS OF BREAKFAST OAT DRINK CONSUMPTION ON BOWEL FUNCTION AND HEALTH PARAMETERS AMONG UTAR KAMPAR FEMALE UNIVERSITY STUDENTS"** under the supervision of **Dr. Tan Gim Cheong** from the Department of Allied Health Sciences, Faculty of Science.

I hereby give permission to the University to upload the softcopy of my final year project report in pdf format into the UTAR Institutional Repository, which may be made accessible to the UTAR community and public.

Yours truly,

(QUAH HONG YI)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

AACC	American Association of Cereal Chemists
BMI	body mass index
CDC	Centers for Disease Control and Prevention
cm	centimeter
cpt-1	Carnitine palmitoyltranferase I
cpt-2	Carnitine palmitoyltranferase II
C. elegans	*Caenorhabditis elegans*
DV	daily value
etc.	et cetera
FODMAPs	Fermentable oligosaccharides, disaccharides , monosaccharides and polyols
GALT	Gut-associated lymphoid tissue
GLP-1	Glucagon-like peptide-1
HCl	Hydrochloric acid
IBS	Irritable bowel syndrome
IBS-C	Irritable bowel syndrome with constipation
IBS-D	Irritable bowel syndrome with diarrhea
IBS-M	Irritable bowel syndrome with mixed bowel habits
IBS-U	Irritable bowel syndrome unclassified

ICU	Intensive care unit
MANS	Malaysian Adult Nutrition Survey
mmHg	Millimeter of mercury
mmol/L	Millimoles per litre
MOH	Ministry of Health
NHANES	National Health and Examination Surveys
NHMS	National Health and Morbidity Survey
NIH	National Institutes of Health
NCDs	Non-communicable diseases
pyy	Peptide tyrosine tyrosine
SCFs	Short chain fatty acids
SAS	Statistical Analysis System
SSBs	Sugar -sweetened beverages
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
UTAR	Universiti Tunku Abdul Rahman
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Research background

In normal daily lives, human beings rely on several different body systems to perform the basic tasks so that our lives can be maintained. There are 10 different body systems that work consistently, which are cardiovascular system, urinary system skeletal system, endocrine system, muscular system, nervous system, lymphatic system, respiratory system, digestive system and the reproductive system. Digestive system breaks down the ingested food mechanically and chemically (enzymes) into absorbable molecules. As food passes down along the gastrointestinal tract and reaches the small bowel (small intestine) and large bowel (colon). Small bowel plays role in nutrients absorption whereas large bowel mainly involved in fluid absorption (University of Michigan Health System, 2008). A healthy bowel ensures human beings get enough nutrients from food, adequate fluid absorption and removal of waste products from our body.

The failure for the bowel to work or function properly is known as the impaired bowel function. One of the most common impaired bowel function is known as irritable bowel syndrome (IBS). According to Rome Foundation (n.d.), IBS can be categorized into four different types which are IBS-C, IBS-D, IBS-M and IBS-U.

IBS is an impaired bowel function which exists worldwide. In Malaysia, about 14% of the population are recorded to have the history of having IBS. Besides, IBS is found to be more common in female population as compared to male population (Segar, 2020).

Consumption of a balanced diet ensures a healthy body and helps to prevent non-communicable diseases such as Type II diabetes mellitus and cardiovascular disease. One of the key factor that promote the development of non-communicable disease (NCDs) is obesity and overweight. Dietary pattern of Malaysians which is prone to consume sugar sweetened beverages (SSBs) is the steppingstones for the high prevalence of obesity and overweight in Malaysia, especially young adults in the age of 20 – 39 years old (NIH, 2019). According to NHMS 2019, both the prevalence of obesity and high blood glucose level are found to have increased as compared to the previous report in year 2011 and 2015. The total population recorded to be overweight or obese have surpass half of the overall populations in Malaysia, with a percentage of 50.1%. A total of 18.3% of Malaysia population is found to have high blood glucose level according to the survey carried out in 2019. Although the prevalence of high blood pressure has recorded a decline trend in the previous 8 years, it is still considered high with 30% from total Malaysian populations in 2019 (NIH, 2019). The development of NCDs is highly correlated to the death before 70 years old in Malaysia, with the percentage of 67%, as reported by Chandran, et al. (2021).

Diet alteration and supplementation is proposed to have beneficial impacts in NCDs' control. Oat or *Avena sativa* (the scientific name), is a type of cereal grain well known to bring various health benefits when consumed. The oatmeal provided almost all of the energy consumed at breakfast for consumers, contributing a mean energy intake of 54.3% across all age groups evaluated (Musa-Veloso, et al., 2016).

Several research has been carried out to study the effects of oat on the bowel function, weight management, blood glucose level, blood pressure. However, there are contradictory results shown among these studies especially the effects of oat on the bowel function (Paruzynski, et al., 2019; Cicero, et al., 2020; Peraaho, et al., 2004; Sturtzel and Elmadfa, 2008). Therefore, the contradictory results obtained by the previous research brings out the queries on how good actually the oat will improve the bowel function and health parameters. Besides, there are lack of studies to be carried out to study the effects of oat among the young adults from age 18 years old to 25 years old. Dietary intake is found to be correlated to the changes of microbiota and white blood cell counts and there is a change of microbiota composition after oat composition (Thurby and Juge, 2017; Ruan, et al., 2021; Ye, et al., 2020; Menni, et al., 2021). However, no research has been carried out to study the effects of oat on the white blood cells counts. In addition, a study carried out by Moy, et al. (2009) among undergraduate public university students found out that there are about 29.2% from them have the habits of not having breakfast. Thus, due to these several reasons, it draws my interest and intention to carry out a research

to study the effects of breakfast oat drink consumption on the bowel function and health parameters among UTAR Kampar female university students.

1.2 Research Objectives

The general objective of our study is to investigate the effects of consumption of commercial oat drink (3 in 1) on bowel function and general health among UTAR Kampar female university students.

The specific objectives of our study are shown as below:

1. To investigate the effects of consumption of commercial oat drink (3 in 1) on stool frequency and gastrointestinal symptoms among UTAR Kampar female university students.
2. To investigate the effect of consumption of commercial oat drink (3 in 1) on weight management among UTAR Kampar female university students.
3. To investigate the effect of consumption of commercial oat drink (3 in 1) on blood glucose level among UTAR Kampar female university students.
4. To investigate the effect of consumption of commercial oat drink (3 in 1) on blood pressure among UTAR Kampar female university students.
5. To investigate the effect of consumption of commercial oat drink (3 in 1) on white blood cells counts among UTAR Kampar female university students.

1.3 Hypothesis

1. Consumption of commercial oat drink (3 in 1) will increase stool frequency among UTAR Kampar female university students.
2. Consumption of commercial oat drink (3 in 1) will improve gastrointestinal symptoms among UTAR Kampar female university students.
3. Consumption of commercial oat drink (3 in 1) will decrease the body weight and BMI among UTAR Kampar female university students.
4. Consumption of commercial oat drink (3 in 1) will decrease the waist circumference and waist-hip ratio among UTAR Kampar female university students.
5. Consumption of commercial oat drink (3 in 1) will decrease the blood glucose level among UTAR Kampar female university students.
6. Consumption of commercial oat drink (3 in 1) will decrease the blood pressure among UTAR Kampar female university students.
7. Consumption of commercial oat drink (3 in 1) will decrease the white blood cell counts among UTAR Kampar female university students.

CHAPTER 2

LITERATURE REVIEW

2.1 Irritable bowel syndrome

Irritable bowel syndrome, or IBS for short, is a type of bowel disorder that troubles a lot of people, and it is present globally. The first written diagnoses of IBS date back to the late 19th and early 20th centuries. According to the statistics, 10% to 25% of the population in a community is diagnosed with IBS. To be more specific, IBS prevalence is 11.2%, according to a meta-analysis, with South Asia accounts the lowest incidence (7.0%) and South America accounts for the highest incidence (21.0%). The prevalence of the IBS in a particular country is highly correlated to the socioeconomic status. According to some reports, IBS is a condition that is more common in nations with high levels of industry and urbanization. The high levels of stress in both wealthy and developing nations are the roots for high IBS occurrence in these countries (Cavanan, West and Card, 2014). In Malaysia, IBS comprises about 14% from the total population , which is much higher as compared to other Asia countries such as Thailand (4.4%), Singapore (2.3%) and Hong Kong (6.6%) (Segar, 2020). IBS affects a large number of people, but sadly, in reality, many of them go untreated. The exact percentage of people who seek medical attention for IBS is only about 30% (Alharbi and Jahan, 2022).

According to the Rome Foundation (n.d.), a person is being diagnosed as IBS when he or she is experiencing an abdominal discomfort periodically with a frequency of occurrence not less than 1 day in a week over the course of the previous three months in addition to two or more criteria stated below: (i) attributed to defecation, (ii) an alteration in the number for bowel movements, (iii) a difference in the stool consistency. This criterion be met for the previous three months, with the first symptoms appears 6 months before detected by the medical professionals. IBS can be classified into main four types which are IBS with predominant constipation (IBS-C), IBS with predominant diarrhea (IBS-D), IBS with mixed bowel habits (IBS-M) and IBS unclassified (IBS-U). All four types of IBS should be recognized in compliance to the stool consistency reference from Bristol Stool Chart and having more than one irregular defecation problem.

Stool consistency or known as degree of firmness is one the diagnostic tool for the healthcare workers to determine the subtypes of IBS which a person is suffering. Stool consistency is basically being determined by using the Bristol Stool Chart, an assessment tool developed in the year of 1997 to determine the types of the feces. Based on the Bristol Stool Chart, the feces or categorized into seven groups, which are Type 1, Type 2, Type 3, Type 4, Type 5, Type 6 and Type 7. The characteristics of each type of stool is shown in the **Figure 1.1.**

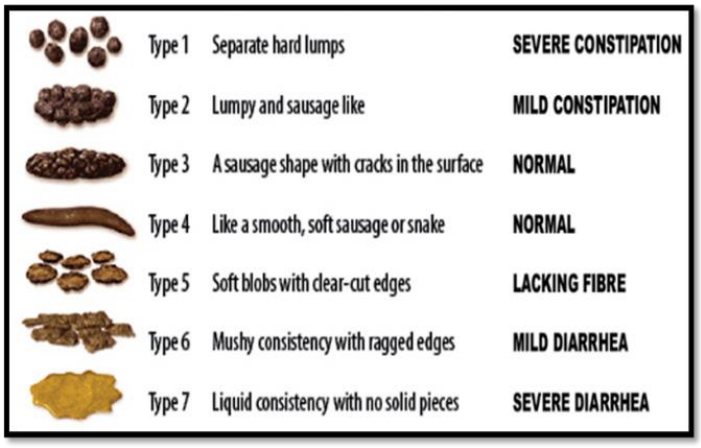

Figure 1.1: Bristol Stool Chart (Continence Foundation of Australia, n.d.)

According to the Rome IV criteria, someone is diagnosed with IBS-C if quarters of their stools are come from Type 1 and Type 2 and fewer than quarters of their stools are Type 6 and Type 7. However, individuals with IBS-D will have a totally different characteristics with the IBS-C, with quarters of their stools are come from Type 6 and Type 7 and fewer than quarters of their stools are Type 1 and Type 2. People with IBS-M have equal percentage of stool come from Type 1, Type 2 (25%) and Type 6 and Type 7 (25%). IBS-U patients meet the requirements for IBS but are not grouped as IBS-C, IBS-D or IBS-M patients, despite having the conditions (Rome Foundation, n.d.).

IBS is a bowel disorder that can be found across a wide variety of ages. The detection for having IBS can be found in children as well as in the elderlies. Over the years, people claimed that IBS is a chronic illness that lasts a lifetime. However, statistics from several studies denied the claim. Canavan, West and Card (2014)

mentioned that the majority of IBS diagnoses are come from those who aged below 35 years old. Seniors who aged 50 years old and above is 25% less likely to have IBS than in those with age below 50 years old. IBS is found most common in younger population that have aged below than 30 years old, reported by Chatila, et al. (2017). A cross-sectional study conducted in three countries of East Asia (Japan, China and South Korea) found that the prevalence of IBS is 12.5% (n=110/877), 12.5% (n=86/687), 15.7% (n=123/782), 13.2%, (n=103/782) and 9% (70/782) for the twenties, thirties, forties, fifties and sixties respectively.

The development of irritable bowel syndrome can be found in both male and female. However, several studies have shown that female has a higher prevalence than male, which the rate is between 1.5 to 3 times greater (Canavan, West and Card, 2014). The rate shown by Canavan, West and Card (2014) is compatible to the study carried out by Chatila, et al. (2017), which draws a conclusion that the prevalence of female in developing IBS is 1.67 times greater than the male. A study carried out among Lebanese population, they found that out of 261 males, 44 males (16.9%) are found to have IBS which is much lower than the percentage of prevalence of IBS for female (22.9%), which 67 females from total 292 female participants are having IBS. AlButaysh, et al. (2020) also reported a higher percentage of female having IBS than male, with the percentage of 9.8% (33/337) for male participants and 20.5% (88/430) for female participants. There is not much difference of male IBS rate with female IBS rate for those live in South Asia, South America and Africa, a statement proposed by Canavan, West and Card (2014). In Malaysia, the

findings are compatible to the statement which prevalence of female having IBS is higher than the prevalence of male having IBS. A research carried out among the medical students with mean age 22 ± 1.8 years old, shown that, 27 males out of total 229 male participants (11.8%) are having IBS whereas 57 females out of total 304 (18.8%) female participants are having IBS (Tan, 2003).

2.2 Malnutrition

According to World Health Organization (WHO), malnutrition includes two different context, which are, lack of nutrient intake and excessive nutrient intake. The existence of malnutrition leads to the imbalance of vital nutrients in the body for maintaining normal health and the failure of using the nutrients by our system (WHO, n.d.). Underweight and obesity are the common presentation of a person suffering from malnutrition. Body mass index (BMI) is one of the indicator used to nutritional status of a person. According to WHO (2010), a person with a BMI in the range of 18.5 kg/m^2 – 24.9 kg/m^2 is classified as normal nutritional status. For those who are below BMI of 18.5, they will be classified into underweight category. Those who are in the range of 25 kg/m^2 – 29.9 kg/m^2, they are overweight and has high possibility to develop into obesity. BMI above 30 kg/m^2 is classified under obesity. According to WHO, obesity can be further sub-classified into obese class I - BMI of 30 kg/m^2 – 34.9 kg/m^2, class II with the BMI of 35 kg/m^2 – 39.9 kg/m^2 and those with BMI greater than 40 kg/m^2 will be known as obese class III. Besides BMI used as the indicator, waist circumference and waist-hip ratio are also used as an indicator to determine the risk for obesity. The cut off points for waist

circumference for both men and women are 85cm and 80cm respectively. whereas the cut-off point of waist-hip ratio for both men and women are 0.90 and 0.80 respectively (WHO, 2008). A person who has waist circumference and waist-hip ratio greater than the cut off points will have the higher risk for obesity and other metabolic risks. In Malaysia, a study carried out by Rezali, Chin and Yusof (2012) in Kajang district of Selangor state, presented that the prevalence of overweight (19.5%) is two times greater than the prevalence of underweight (10.5%). There is an increase in the prevalence of obesity from year 2011 to year 2019, reported by a survey carried out across the country, with a gradual increase from the year 2011 (15.1%) to 2015 (17.7%) and 2019 (19.9%).

2.3 Blood glucose level

Human beings require energy to complete their daily work. The main source that human beings obtain energy from is carbohydrates, one of the macronutrients required by human beings other than proteins and fats. When carbohydrates are taken into the human digestive system, the carbohydrates will first break down into smaller pieces via physical mechanism, further down broken into smaller molecules, the monosaccharides, via chemical mechanism by enzymes. These smaller monosaccharides molecules will then be absorbed by our villi in our small intestine for the use of the cells and tissues (Marengo, 2018). In the blood, our blood glucose is controlled by a type of hormone known as insulin and glucagon. When the blood glucose rises, the insulin will be secreted by the pancreas whereas glucagon will be synthesized when blood glucose is found to be low in our body. Both hormones are

crucial in bringing our blood glucose level back to normal (Center for Disease Control and Prevention, 2022). One of the indicator for diagnosis of diabetes is by using fasting blood glucose level tests, as shown in follows: (i) normal: <5.6mmol/l (ii) pre-diabetes: 5.6 – 6.9mmol/l (iii) Diabetes: >6.9 mmol/l (Mayo Clinic, 2022). Diabetes mellitus is a disease that should be highly concerned. Recently, the prevalence of diabetes is showing an increasing rate. According to the World Health Organization (WHO), prevalence of diabetes has recorded a total of 422 million people around the globe, which leads to an estimated death of 1.5 million every year (World Health Organization, n.d.). Among these statistics, the citizens from low and middle-income countries are at higher probability to have diabetes. A systematic review and meta-analysis from Akhtar, et al. (2022), has reported that the prevalence of diabetes in Malaysia is high (14.39%). Indians are the most likely population (25.10%), followed by Malays (15.25%), Chinese (12.87%), aborigines (8.62%) and others (6.91%).

2.4 Blood pressure

Blood pressure is an indicator of how hard a person's heart has to work to circulate blood throughout the body. There are two terms which are normally used by the medical and healthcare professionals to define blood pressure, which are systolic and diastolic blood pressure. Systolic blood pressure is the force applied by the blood towards the artery walls during heart contraction whereas diastolic blood pressure is the force applied by the blood towards the artery walls between heartbeats. Both systolic blood pressure and diastolic blood pressure are measured

in the form of mmHg. According to the American Heart Association (2023a), the indication of blood pressure to health can be categorized into several groups. A normal person tends to have both systolic blood pressure and diastolic blood pressure in the range of 90 - 120 mmHg and 60 - 80 mmHg respectively. Hypotension is a term that refers to a person is having low blood pressure, indicated by having systolic blood pressure below 90 mmHg and diastolic blood pressure below 60 mmHg. The existence of hypotension is due to several factors such as lack of adequate intake of nutrients, infections, dehydration etc. (American Heart Association (2023b). Another medical term that is well known and normally being concerned is known as hypertension, characterized by having a high blood pressure readings. Hypertension is highly correlated to the development of cardiovascular morbidity and motility, with other severe complications such as kidney dysfunction, brain injuries, eye damage and failure in reproductive system (Mayo Clinic, 2022; Franklin, 2006). The hypertensive status of a person can be further categorized into elevated state, hypertension stage 1, hypertension stage 2, and hypertensive crisis, as shown in **Figure 2.1**.

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)	and/or	DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Figure 2.1: Classification of blood pressure (American Heart Association, 2023a)

2.5 Oat

Oat is a member from the plant with the family name Poaceae (Harvard T.H. Chan, n.d.). According to Rasane, et al. (2015), the bulk of the world's oats are grown in American and European countries, including Russia, Canada, and the United States. Consumers take an average of 238 g of cooked oatmeal daily, or roughly 6% of the population overall, according to data on dietary intake from Day 1 of the 2011-2012 U.S. NHANES.

2.6 Fiber

As we know, carbohydrates are the macronutrients that are required by human beings as the main source of energy in our daily lives. Fiber is a type of the carbohydrate, yet it is unable to be digested in the human gastrointestinal tract. Over the years, the definition of fiber has been amended regularly. The first definition of dietary fiber was proposed by McCance and Lawrence in the year 1929 as ‘unavailable carbohydrate’. In the year 1953, Hipsley suggested a more complete definition which dietary fiber is a structure of the plant cell wall, in which, when it is consumed, this component is unable to be digested and broken down. The latest update definition of dietary fiber in the year 2000, American Association of Cereal Chemists (AACC) acknowledges that resistance to digestion and absorption in the small intestine, as well as fermentation in the large intestine, are the main properties of dietary fiber (Food and Nutrition Board and Institute of Medicine, 2001). The fiber can be categorized into two main categories, which are, soluble fiber and

insoluble fiber. Soluble fiber is a type of fiber that dissolved in water whereas insoluble is a fiber that cannot be dissolved in water.

2.6.1 Characteristics of soluble fiber and its benefits

Soluble fiber, is characterized by the ability to be dissolved in water, is known to increase the duration of food to pass through the digestive tract, increasing the time for glucose to be absorbed and postpones gastric emptying. This can be explained by its viscosity characteristics (ability to absorb water) and the ability to form gel structure when it passes through the intestinal tract, which increase the volume of the gastrointestinal contents (Mudgil, 2017). The ability of soluble fiber to absorb water may lead to the improvements in person with diarrhea. The benefits of soluble fiber can be shown by a clinical trial carried out by Homaan, et al. (1994), which shown diarrhea symptoms of the patients have been improved since the intervention with soluble fiber is given. Similar positive results of soluble-fiber prescription in improving diarrhea for ICU patients have been shown by the Rushdi, et al. (2004). As mentioned, soluble fiber postpones gastric emptying, which may make a person to feel full and reduce hungriness, which is best for patients who is undergoing weight management therapy (Mudgil, 2017). From a study from Perrigue, Monsivias and Drenowski (2009), the addition of fiber into low-density yogurt can allow a person to feel full, thus therefore have a better regulation of appetite and limit the food being taken at one time. Besides, soluble fiber reduces the plasma cholesterol level as the gel matrices formed by the soluble fiber will attract and hold the bile acids secreted by the liver. In the end, the gel matrices formed, together

with the bile acids will be removed from our body. Besides, when bile acids are trapped by the dietary fiber, the broken down and absorption of lipid in the small intestine will be decreased as there is decreased emulsification, which is done by the bile acids (Mudgil, 2017).

2.6.2 Characteristics of insoluble fiber and its benefits

The insoluble fiber is characterized by its inability to absorb water, inability to form gel-structure, limited fermentation in the colon, high porosity and low density. These special characteristics of insoluble fiber lead to the formation of large fecal bulk, promoting the bile acids removal and reduce the intestinal transit time. Thus, the insoluble fiber is found to be correlated in improving the constipation. The effects of the insoluble fiber in improving constipation are summarized by a review article carried out by Bae (2014). From this review article, fruits, legumes and vegetables which are claimed to be rich in insoluble fibers are found to have a relationship in reducing the occurrence of constipation. Water-insoluble fiber from wheat bran and rye bran can be used to treat constipation with promising result which shows a significant increase in the frequency of bowel movement and a significant reduction of defecation difficulty.

2.6.3 Prevalence of fiber consumption

The American Heart Association Eating Plan advises the public to choose and consume a range of food sources that are high in fiber. A total of 25 to 30 grams of

dietary fiber are recommended as daily fiber requirement, proposed by American Heart Association Eating Plan (UCSF Health, n.d.). The similar quantity for fiber consumption has been recommended by the Ministry of Health Malaysia. Based on the Recommended Nutrient Intakes for Malaysians, the intake of dietary fiber for a person every day should be in the range of 20g to 30g (Rohida, Junidah and Faulinan, 2008). Besides, to promote healthy eating patterns, MOH Malaysia also introduces a healthy eating plate known as 'Suku-Suku Separuh' , with a quarter of plate is occupied with whole grains and protein source respectively and another half plate is occupied with vegetables and fruits.

However, it seems that the consumption of fiber among the citizens is not reaching what has been recommended. García-Meseguer, Delicado-Soria and Serrano-Urrea (2017) carried out a research in three different countries from three different continents among the university students, who are from University of Castilla-La Mancha (Spain), University of Carthage (Tunisia) and Florida International University (United States). From these three countries, the average consumption of fiber among the university students is 17.8 g/day, which is lower than the recommendations. In Malaysia, a review from Ng, et al. (2010) shows the average fiber intake is not desirable in three different targeted populations (Course participants, university students and research institute staff). The average dietary fiber consumption by course participants is 10.7 ± 1.0 g/day, 15.6 ± 1.2 g/day for university students and 16.1 ± 6.1 g/day for research institute staff. A statistics from MANS 2003 report an average of 19.2g dietary fiber is being taken by Malaysians

and there are still more than half Malaysians who ate less than the 20 g/day required consumption.

2.6.4 Oat as source of dietary fiber

Oat is one of the food that can be claimed to be rich in dietary fiber. Based on the Malaysian Food Composition Database, consumption of 100 grams of the processed oats can give us 1.5 g of fiber (Malaysian Food Composition Database, 1997). Oat contains both soluble and insoluble fiber, which the soluble fiber in oat makes up 55% whereas the insoluble fiber makes up 45% out of total fiber content (Sharma and Chawla, 2011). As similar with other dietary fiber, the fiber in oat is claimed to serve several benefits which includes improve the bowel function, improve the blood glucose level and blood pressure and better food choice for weight management.

2.7 Benefits of oat consumption

2.7.1 Oat and bowel function

Since oat contains both soluble and insoluble fibers, oat is claimed to have good impacts in improving the bowel function. However, there are contradictory results in showing the positive relationship of oat and the bowel function. Paruzynski, et al. (2019) carried out a 2-week study in children aged 7-12 years old to determine the bowel function before and after the oatmeal intervention. From their study, they

found out that there are no changes in bowel movement and stool consistency observed among the children. The subjects did, however, have less indications of straining, less gas production, and fewer feelings of incomplete defecation. The insignificant changes of frequency for having defecation and stool consistency before and after intervention is further proven by Cicero, et al. (2020), which involve 83 participants with Italy nationality. The result from this study also illustrates that participants do not feel any abdominal pain changes before and after the intervention. However, in the study from Peräaho, et al. (2004), there are some participants experience abdominal pain and have the sense of bloating during the intervention, which therefore causes them to refuse to further be involved in the intervention. This study also shows two distinct contradictory results with oatmeal consumption may worsen the constipation symptoms score and also is more likely to cause a person to develop diarrhea. A controlled blind parallel intervention trial which involves a group of people from nursing homes with laxative usage has shown that the constipation symptoms they experience alleviated and the rely towards laxatives has been reduced after giving oat bran intervention for 12 weeks (Sturtzel and Elmadfa, 2008).

2.7.2 Oat and weight management

It has been discovered that oat consumption is associated with weight management, with a drop in weight and BMI. In order to determine the correlation between oats consumption and weight, Musa-Veloso, et al. (2016) reviewed data from the National Health and Examination Surveys (NHANES). Review of NHANES data

from the years 2001 to 2010 reveals that individuals over the age of 19 and children between the ages of 2 and 18 who regularly consume oats will have healthier body weights. Review of NHANES data from 1999 to 2004 shows that women who choose oats for breakfast will have lower BMIs, whereas men do not exhibit this trend. Additionally, instant oats are discovered to encourage BMI improvement. A contradict results have been shown by two different studies: studies from Valle-Jones (2008) which found good impacts of oat in reducing weight after 12 weeks intervention and studies from Sturtzel and Elmadfa (2018), with no impact of oat on the body weight of the elderly. Besides looking at the body weight and BMI, waist circumference is also an indicator for body weight management. Both studies from O'Neil (2015) and Chang, et al. (2013) found out that oatmeal consumption can reduce the deposition of abdominal fat, which then reduces the waist circumference. The reason for oatmeal consumption in improving weight management may be due to the increase satiety experienced after oatmeal intake as a result of the effects of oat β-glucan (Geliebter, et al., 2015). Although oat may seem to promote weight loss by increasing satiety and delayed gastric emptying due to the presence of fiber, yet oat is considered as cereal grains, which will also provide 75 calories in one exchange. The processing of instant oat with the excessive sugar added may also promote the weight gain. Therefore, the question for the future study is to investigate whether the oat drink consumption especially whether instant oat intake will promote weight gain or weight loss in healthy individual without obesity.

2.7.3 Oat and blood glucose level

The effect of oat B-glucan in improving the blood glucose level can be shown by following two studies. Barati, et al. (2021) conducted a research on the effects of oat bran consumption in mothers who have suffered from gestational diabetes during pregnancy, with two groups (intervention group and control group). For four weeks, the intervention group received 30g of oat bran every day at lunch and dinner. In the final results, there is a significant decrease in mean fasting blood glucose and two-hour postprandial glucose in the intervention group as compared to the control group. Another study looked at the results of giving Type-2 diabetes patients oat B-glucan as a dietary supplement for three months. The findings showed that consuming 5g of oat B-glucan for a period of 12 weeks can enhance glycemic management and improve satiety (Pino, Mujica and Arredondo, 2021). The limitation for these two studies is they focused on the people who are having the diabetes, either gestational diabetes or Type-II diabetes. The effect of oat to normal people, especially the young adults are questionable and needs further investigation.

2.7.4 Oat and blood pressure

Another advantage of oats is that they can lower blood pressure. Numerous studies have found favorable effects of oat eating on blood pressure. The first investigation was conducted by Maki, et al. (2006) and is a randomised, double-blind, controlled clinical experiment. After receiving an oat-glucan intervention for 12 weeks, 97

patients in this clinical research with average systolic blood pressure of 130-179mmHg, diastolic blood pressure of 85-109mmHg, and high BMI saw improvements in their blood pressure. However, without taking BMI into account, blood pressure was not showing significant difference across the groups under study. From a research carried out in China, 25 participants who has distributed into the oat bran supplement intervention had better in both systolic and diastolic blood pressure profiles as compared to the other 25 participants who did not receive any oat bran supplement intervention (Xue, 2020). Following a 6-week oatmeal regimen, both systolic blood pressure and diastolic blood pressure of participants have dropped 7.5 mmHg and 5.55 mmHg respectively, according to the result reported by a study from Keenan, et al. (2002).

2.8 Dietary modulation on gut microbiota and immunity

The concept of "gut microbiota" describes the broad spectrum of bacteria, archaea, and eukaryote that live in the GI tract and have developed together with the human body over thousands of years to establish a complicated and advantageous association. There are found to have more than 10^{14} of microorganisms living in the human gastrointestinal tract. The balance of the gut microbiota promotes several health benefits which include boosting intestinal health, supply energy to humans by involving in energy metabolism after the fermentation of dietary fiber which produces short chain fatty acids (SCFAs), eradicate the infections and promoting good health immunity (Thursby and Juge, 2017; Besten, et al., 2013). The equilibrium of different species of gut microbiota is highly dependent on the diet

and the food that we consumed every day. According to Ruan, et al. (2021), the genus Bacteriodes and Faecalibacterium are found to be increased with the increase in the potato consumption. Studies which involve 28 participants found there is an elevation of the Firmicutes phylum but loss of Bacteroides phylum and Proteobacteria phylum after giving oatmeal intervention (Ye, et al., 2020). Gut microbiota is mostly responsible for maintaining the balance between host defense and immune tolerance, with changes in number of the white blood cells, which as an indicator for the inflammation. Microbe also plays an important role in IBS. Bad microbe could cause inflammation and lead to the increase in white blood cells. From the previous studies, those who consume more vegetables are found to have a lower levels of Collinsella phylum, and the number of white blood cells, lymphocytes and basophils are decreased, which define there is an improving in inflammation. Consumption of potato is also found to be correlated with low number of white blood cells. However, not all types of food will have the association with the white blood cells counts. For instance, fruit intake is found to have no impacts on the white blood cells counts (Menni, et al., 2021, Ruan, et al., 2021). Although studies have shown that consumption of oats, which is rich in fiber, would serve as food for microbe and promote growth of certain phyla and the changes of total microbiota composition, which later promote the changes of white blood cells counts, yet there is no research being carried out to study the effects of oatmeal consumption on the white blood cell counts. Therefore, further research is needed to be conducted to study this field.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Materials, chemicals and equipment

All the materials, chemicals and equipment used in this current study are listed in **Table 3.1** and **Table 3.2** as shown in below:

Table 3.1: List of materials and chemicals used

Materials and chemicals	**Brand/Model**
3 in 1 instant oat drink	Quakers
Leishman stain	HiMedia
Methanol	EMSURE

Table 3.2: List of equipment used

Equipment	**Brand/Model**
Stadiometer	Charder HM202P
Karada scan	OMRON
Glucometer	ONE TOUCH
Glucometer strips	ON-CALL PLUS
Digital sphygmomanometer	OMRON

Table 3.2 continued: List of equipment used

Equipment	Brand/Model
Lancet's device	ACCU CHEK
Optical microscope	Leica

3.2 Methods

3.2.1 Overview of research methodology

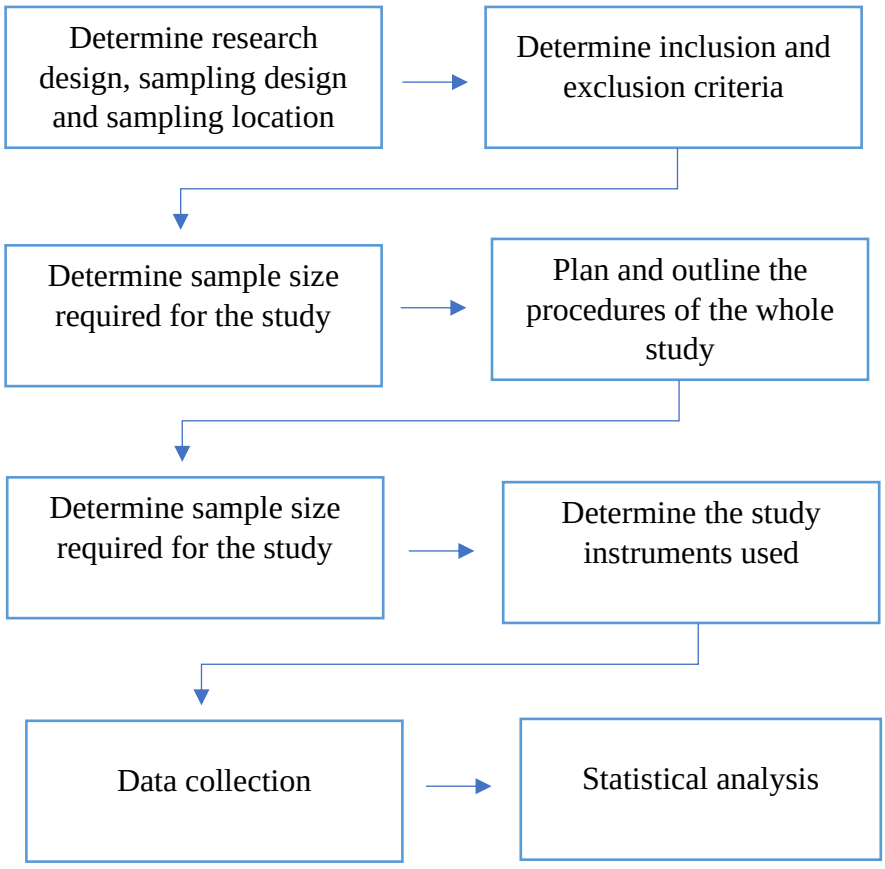

Figure 3.1 Overall workflow

3.2.2 Research design, sample design, sampling location

This study is an intervention study conducted in Universiti Tunku Abdul Rahman (UTAR). Intervention study is a study in which an intervention (potential drugs, medical devices, activities or procedures) is given to the participants to study its effects on the subjects. In our study, the intervention used is by giving the participants a package of commercial oatmeal drink (3 in 1) to investigate its effect in improving the bowel function and general health among UTAR Kampar female students. A convenience sampling method is applied in this intervention study.

There are some criteria has been set to be recruited as participants in this study. For participants who are included in our study, they must be Malaysia citizens, students who aged in between 18 – 25 years old and is a female. Students who undergo chronic medical therapy, consume antibiotics in the past month, consume fiber supplements and have the habits of consuming cereals every morning will be excluded from our study. The inclusion and exclusion criteria are listed out in **Table 3.3**.

Table 3.3: Inclusion and exclusion criteria

Inclusion criteria
1. Students who are Malaysian citizens.
2. Students with aged in between 18 – 25 years old.
3. Students who are female.

Table 3.3 continued: Inclusion and exclusion criteria

Exclusion criteria
1. Students who undergo chronic medical therapy.
2. Students who consume antibiotics in last month.
3. Students who consume fiber supplements.
4. Students who have the habits of consuming cereals every morning.

3.2.3 Sample size

The sample size was determined by using the Danial (1999) single population proportion formula, as shown below:

$$\mathbf{n} = \frac{z^2 \, \mathrm{p} \, (1-p)}{d^2}$$

n = sample size

z = standard normal variate

p = expected population proportion from previous research

d = precision

From the previous study, the prevalence of participants of female university students having irritable bowel syndrome is 18.8%. Accordance to 95% confidence level, 1.96 was used for the standard normal variate (z), 5% of precision was fixed and the expected population proportion was 0.188. With the use of formula

calculated for sample size mentioned above, the expected sample size for our study will be:

$$\mathbf{n} = \frac{1.96^2\,(0.188)(0.812)}{0.05^2}$$

$$= 234.57$$

$$\approx 235$$

Since the research conducted is a pilot study, the sample size of the pilot study will be 10% of the estimated sample size (Connelley, 2008).

$$\mathbf{n} = \frac{235 \times 10}{100}$$

$$= 23.5$$

$$\approx 24$$

From the calculated sample size for pilot study, consider the drop-out rate and students excluded during intervention as 10%,

$$\textbf{Drop - out rate and exclusion} = \frac{24 \times 10}{100}$$

$$= 2.4$$

$$\approx 2$$

$$\textbf{Final sample size} = 24 + 2$$

$$= 26$$

3.2.4 Study procedures

This study is approved by UTAR with reference number U/SERC/112/2023 as shown in **Appendix A**. The intervention aims to study the effect of oat drink intervention on the bowel function and the health parameters among UTAR Kampar female university students. A total of 26 participants were recruited in UTAR Kampar campus based on the inclusion and exclusion criteria. Before the intervention starts, the participants were asked to fill in the questionnaires which consist of a series of questions. Besides filling the questionnaire, the height, weight, blood glucose level and blood pressure were taken. Furthermore, blood was taken from the participants to make the blood smear. After all these measures were taken, the participants were provided with Quaker's instant 3 in 1 oatmeal drink brought from the supermarket. There are 15 sachets of oatmeal drink in one package. The participants were required to consume one sachet of instant oatmeal drink in addition to their usual breakfast each day during the intervention period. The intervention week was lasted for 14 days. During these 14 days, besides include the instant oatmeal drink in the participants' breakfast, the participants were allowed to follow their usual diet habits without any restriction of food. Furthermore, in the intervention week, the participants were asked to complete the bowel diaries and food diaries for 14 days. After 14 days, a post-intervention data collection was carried out among participants. The participants' body weight, fasting blood glucose and blood pressure were taken again after 14 days of the intervention. Blood smear was performed again after 14 days of the intervention.

3.2.5 Study instruments

3.2.5.1 Questionnaire

The questionnaire is used for our study to determine the effects of oat drink consumption on the bowel function and health parameters. The questionnaire is divided into several sections, which are, Section A – Sociodemographic profile, Section B – Additional information, Section C – Anthropometric measurements, Section D – Bowel function analysis, Section E – Blood analysis. Each section is further discussed in detail as below:

Section A: Sociodemographic profile

In section A, six questions are asked to obtain the general information of the participants. The questions that are included in this section include name of the participants, age of the participants, birth date, ethnicity, field of study and year of study. Five questions are designated in the short answer form, in which the patients are required to fill in their particulars on the empty space. Only one question (ethnicity) in this section is in option form, in which the participants are required to choose the answers that are relevant to them (**Appendix B**).

Section B: Additional information

After knowing the basic particulars of the participants, in the following section, section B, more questions are asked to obtain the additional information about the

participants. The purpose of getting the additional information in this section is to determine some possible reason that might affect the intervention. Besides, questions for criteria for exclusion were asked in this section. In total, there are 12 questions in this section. Both optional methods (yes or no) and short answer methods are used in this section (**Appendix B**).

Section C: Anthropometric measurements

There are a total of 6 questions included in this section. This section is filled after the researcher has performed the measurements from participants. Some anthropometric measurements carried out in this section include height, body weight, waist circumference and hip circumference. The BMI of the participants is calculated after the body height and body weight of the participants are obtained by using the formula BMI = weight (kg) / height (m^2). Waist-hip ratio is obtained by dividing the waist circumference by the hip circumference. The importance of this section in the study is to investigate the effects of commercial oat drink intervention on anthropometric measurements (**Appendix B**).

Section D: Bowel function analysis

The purpose of this section is to determine whether the commercial oat drink intervention has an impact on the bowel function. 12 questions are being included in this section which include the total number of days that the participants having bowel movements, total frequency for the participants to have bowel movements

and the gastrointestinal symptoms such as abdominal pain, experience urgency, hard bowel motions, experience straining symptoms, diarrhoea and etc. All of these 12 questions are asked in the short answer form, in which the participants are required to recall their bowel activity for the past 14 days and record on the space given (**Appendix B**).

Section E: Blood analysis

The participants are not required to fill in this section. This section is filled by the researchers after measuring the biochemical data (fasting blood glucose level) and clinical data (blood pressure) of the participants. The information on the participants' blood is recorded down after observing the blood smear under optical microscope. The purpose of this section is to investigate the effects of oat drink consumption on the blood glucose level, blood pressure and white blood cells counts of the participants after 14 days of intervention (**Appendix B**).

3.2.5.2 Bowel diary

During the intervention week of 14 days, the participants are required to record their bowel movements specifically when they are going to the toilet for the bowel motion. The purpose of the bowel diary is to determine the possible difference of the stool frequency of the participants before and throughout the intervention week. Besides, bowel diary is used as a tool for cross check the data for bowel frequency

filled by the participants in the questionnaire after 14 days of intervention to prevent underreported data due to the limitations of recall (**Appendix C**).

3.2.5.3 Food diary

Besides filling the bowel diary for 14 days in the intervention, the participants are also asked to complete a food diary every day. The participants are asked to fill in what they have eaten and estimate the portion sizes of food and drinks they have eaten. A guide of estimating the portion sizes of food is attached at the back of the food diaries. The purpose of the food diary is to determine the possible effects of the diet which is taken by the participants every day and the dietary pattern of the participants on the parameters studied in this research (**Appendix D**).

3.2.6 Collection of data

3.2.6.1 Anthropometric measurements

The anthropometric measurements include the body height, body weight, waist circumference and hip circumference were taken. The body height of the participants was measured by using the stadiometer. The participants were asked to stand on the stadiometer after removing the shoes. The height of the participants was recorded with the head of the participants in the Frankfurt plane and the back of the participants touching the stadiometer. After performing the body height measurements, the participants were asked to stand on the Karada scan with

removal of all the extra substances from the pocket of the participants to record the body weight of the participants.

Waist circumference and hip circumference measurements were performed in our study by using the measuring tape. Due to the ethical issue, I asked a female friend from the Dietetics course to help me to perform the waist circumference and hip circumference measurements. The waist circumference and hip circumference measurements were taken based on the guidelines from WHO. (2017). The waist circumference is in the middle point between the last rib that can be felt by our hand and the iliac crest in the mid axillary line. Hip circumference is at the position of the most protuberance of the buttocks.

3.2.6.2 Blood glucose level and blood pressure

The fasting blood glucose level of the participants were taken by using the glucometer after a drop of blood of the participants was placed on the blood glucose strip. The blood pressure of the participants was taken by using the digital sphygmomanometer and the process was repeated twice.

3.2.6.3 Blood smear

Blood was taken from the participants after pricking the participants' finger by using the lancet device. The blood collected from the participants was dropped onto

a microscope slide. The spreader slide was placed at the end of the microscope slide with the participants' blood with an angle of 30 degrees to 40 degrees. The spreader slide was then pulled slowly from the end of the microscope slide to the blood to allow the blood to spread fully on the spreader slide. Once the blood was fully spread, the spreader slide was then immediately pushed towards the end of the microscope slide to allow a perfect blood smear to be formed. A simple blood smear making procedure is shown in **Figure 3.2** (CDC, 2004). An example of thin blood smear is shown in **Figure 3.3**.

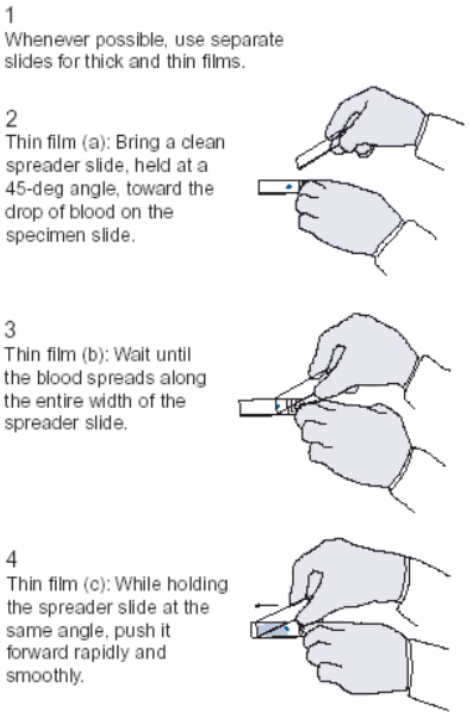

Figure 3.2: Blood smear making procedure

Figure 3.3: An example of thin blood smear

3.2.6.4 Staining

The blood smear was soaked in methanol for seconds to fix the blood cells on the microscope slide for better preservation. For the observation of blood cells, the blood smear was needed to undergo staining. The blood smear was allowed to flush with the Leishman stain. The blood smear with Leishman stain was washed with dilute water. After diluting, the blood smear was flushed with the Leishman stain for the second time to allow more cells to be stained. After proper staining, the microscope slide with blood smear was washed under tap water. The cover slide was sticked on the microscope slide by using the methanol solutions. The component of the blood smear was then observed under the microscope. The white blood cells count, and red blood cells counts were performed. The ratio of white blood cells to 1000 of red blood cells were calculated. (Department of Primary Industries and Regional Development, 2017; Adewoyin and Nwogoh, 2014).

3.3 Statistical analysis

3.3.1 Descriptive analysis

Before carrying out the statistical test, the raw data collected from the participants are displayed by using the descriptive analysis. Descriptive analysis is used to summarise the complicated raw data to provide the readers to have a better understanding about the results of the research. To describe the sociodemographic data in the section A of the questionnaire, frequency (n) and the percentage (%) are used. Mean and standard deviation were used to describe the discrete data (variables for bowel function such as number of days for having bowel movement), continuous data (health parameters such as blood glucose level) and the ratio of white blood cells to 1000 red blood cells.

3.3.2 Chi-square test

Chi-square test, also known as goodness of fit test, is used in our study to test for the discrete data. In our study, the variables that can be categorised as discrete data are ‘number of days for having bowel movements’, ‘total frequency of bowel movements for the past 14 days’, ‘number of days having gastrointestinal symptoms such as hard bowel motions, discomfort or abdominal pain, straining symptoms, having loose mushy or watery stool, diarrhoea and urgency symptoms’. Goodness of fit test is a statistical test to define whether the observed value is different from the expected value. In our study for the effects of oat of the bowel function, we expect to get no difference in the observed value and the expected

value before and after the oat intervention. The comparison of the $\chi 2$ value with the critical value is used to differentiate whether there is difference between the observed value and the expected value. At $\alpha = 0.05$, $\chi 2$ value greater than the critical value of 3.841 is considered to have significant difference. The variable is considered to possess a very high significant difference if the $\chi 2$ value is greater than the critical value of 6.635. We perform goodness of fit tests by using Microsoft Excel.

3.3.3 Paired T-test (dependent T-test)

Paired T-test or also known as the dependent T-test is used in our study to perform statistical analysis on the continuous data before and after the oat drink intervention. Paired T-test is performed to determine whether the measurements (must be continuous data) from one group differ from the other. In our study, all the parameters that performed measurements such as weight, BMI, blood pressure, and blood glucose level are continuous data, which can be tested by using the paired T-test. The study of the oat drink effects on the white blood cells is also tested by paired T-test after calculating the ratio of white blood cells to 1000 of red blood cells. In our study, we expect there is no difference in the parameters before the oatmeal drink intervention and the parameters after the oatmeal drink intervention. A significant difference is detected if the p-value obtained is smaller than 0.05. To perform paired T-tests, we use an online software designated for the researchers to

analyse the data for free. This online software is known as SAS OnDemand Academics.

CHAPTER 4

RESULTS

4.1 Sociodemographic characteristics

Table 4.1 shows the sociodemographic characteristics of the participants. The total participants involved in this intervention study is 26 participants who are recruited from Universiti Tunku Abdul Rahman (UTAR). In line with the inclusion criteria for this intervention study, from these 26 participants, all of them are female (100%) with Chinese ethnicity (100%). In this intervention study, we recruited the participants with age group in the range of 18 – 25 years old. Out of 26 participants, most of the participants are 22 years old (n=15, 57.7%), followed by 20 years old (n=3, 11.5%), 23 years old (n=3, 11.5%), 19 years old (n=2, 7.7%), 21 years old (n=2, 7.7%), 24 years old (n=1, 3.8%) and none of the participants is aged 18 and 25. Students from Bachelor of Science (Honours) Dietetics (n=16, 61.5%) comprise most of the participants enrolled, followed by students from Bachelor of Economics (Honours) Financial Economic (n=3, 11.5%), students from Bachelor of Science (Honours) Food Science (n=2, 7.7%), students from Bachelor of Science (Honours) Microbiology (n=2, 7.7%), students from Bachelor of Information System (Honours) Business of Information System (n=1, 3.8%), students from Bachelor of Commerce (Honours) Accounting (n=1, 3.8%) and students from Bachelor of Computer Science (Honours) (n=1, 3.8%)

Table 4.1: Sociodemographic characteristics of respondents (n=26)

Variables	Frequency	
	N	%
Gender		
Male	0	0
Female	26	100
Ethnic		
Malay	0	0
Chinese	26	100
Indians	0	0
Others	0	0
Age		
18	0	0
19	2	7.7
20	3	11.5
21	2	7.7
22	15	57.7
23	3	11.5
24	1	3.8
25	0	0
Field of study		
Business of information system	1	3.8
Commerce accounting	1	3.8
Computer science	1	3.8
Dietetics	16	61.5
Financial economic	3	11.5
Food science	2	7.7
Microbiology	2	7.7

4.2 Effects of oat drink intervention on bowel activity

In this study, we investigate the effects of oat drink intervention on the bowel activity of the participants. The total number of days for 26 participants to experience bowel movements and the total frequency of bowel movements for the past 14 days before and after the oat drink intervention are shown in **Table 4.2.** Before the intervention, the average total number of days with bowel movements for 26 participants are 8.96 ± 3.79 days. After being given the oat drink intervention, the average total number of days with bowel movements for 26 participants have been increased to 10.62 ± 2.94 days. However, this increased does not show a significant difference ($\chi2 = 3.63 < 3.841$ at $\alpha=0.05$, $\chi2 = 3.63 < 6.635$ at $\alpha=0.01$). The average frequency of bowel movements for the past 14 days has increased from 9.65 ± 4.21 times (last 14 days before intervention) to 12.27 ± 4.65 times after intervention with a $\chi2$ value of 8.17 which shows the incline of the result is significant difference at $\alpha =0.01$.

Table 4.2: Total number of bowel movements and total frequency of bowel movements before and after the oat drink intervention

	Pre-intervention	**Post-intervention**	**$\chi2$**
Total number of days of experiencing bowel movements (days)	8.96 ± 3.79	10.62 ±2.94	3.63
Total frequency of bowel movements for the past 14 days	9.65 ± 4.21	12.27 ± 4.65	8.17 **

****significant difference when $\chi2 > 6.635$ at $\alpha =0.01$**

4.3 Effects of oat drink intervention on gastrointestinal symptoms

There are six variables of gastrointestinal symptoms being analyzed from the self-reported questionnaire. The results are tabulated and presented in **Table 4.3**. Firstly, the number of days which the participants experiencing hard bowel motions indicating a decline trend from the average of days 1.15 ± 1.35 before oat drink intervention to 0.77 ± 0.93 after oat drink intervention. However, this decline trend does not show a significant difference ($\chi 2 = 2.00 < 3.841$ at $\alpha=0.05$, $\chi 2 = 2.00 < 6.635$ at $\alpha=0.01$). Secondly, there is a significant increase in the average number of days for participants in experiencing discomfort/pain in abdomen that related to bowel activity from 1.27 ± 1.32 days before oat drink intervention to 2.00 ± 1.84 days after oat drink intervention ($\chi 2 = 4.25 > 3.841$ at $\alpha=0.05$). There is no significant decrease for the straining symptoms from 1.08 ± 1.36 days before oat drink intervention to 0.77 ± 1.12 days after intervention ($\chi 2 = 3.14 < 3.841$ at $\alpha=0.05$, $\chi 2 = 3.14 < 6.635$ at $\alpha=0.01$). Next, both the variables of 'experiencing loose, mushy or watery bowel motions' and 'diarrhea' does not show a significant difference although there is an increase average number of days presented by both symptoms. The variable 'experiencing loose, mushy or watery bowel motions' increase from 0.73 ± 1.43 days before oat drink intervention to 1.04 ± 1.68 days after oat drink intervention ($\chi 2 = 1.39 < 3.841$ at $\alpha=0.05$, $\chi 2 = 1.39 < 6.635$ at $\alpha=0.01$). whereas the variable 'experiencing diarrhea' elevated from 0.35 ± 0.68 days before oat drink intervention to 0.62 ± 1.18 days after oat drink intervention ($\chi 2 = 1.96 < 3.841$ at $\alpha=0.05$, $\chi 2 = 1.96 < 6.635$ at $\alpha=0.01$). Lastly, there is a highly significant incline in the average number of days for participants having urgency

symptoms ($\chi 2 = 10.24 > 3.841$ at $\alpha=0.05$, $\chi 2 = 10.24 > 6.635$ at $\alpha=0.01$) which the average number of days increase from 0.77 ± 0.97 days to 1.77 ± 2.33 days.

Table 4.3: Gastrointestinal symptoms before and after the oat drink intervention

	Pre-intervention	**Post-intervention**	**$\chi 2$**
Hard bowel motions (days)	1.15 ± 1.35	0.77 ± 0.93	2.00
Discomfort/pain in abdomen related to bowel activity (days)	1.27 ± 1.32	2.00 ± 1.84	4.25 *
Straining (days)	1.08 ± 1.36	0.77 ± 1.12	3.14
Loose, mushy or watery bowel motions (days)	0.73 ± 1.43	1.04 ± 1.68	1.39
Diarrhea (days)	0.35 ± 0.68	0.62 ± 1.18	1.96
Urgency (days)	0.77 ± 0.97	1.77 ± 2.33	10.24 **

*** significant difference when $\chi 2 > 3.841$ at $\alpha = 0.05$**

**** significant difference when $\chi 2 > 6.635$ at $\alpha = 0.01$**

4.4 Trend of number of participants to the changes of bowel activity and gastrointestinal symptoms after oat drink intervention

To understand more about the pattern changes of bowel activity and gastrointestinal symptoms with and without oat drink intervention, we investigate the trend of number of participants to the changes of bowel activity and gastrointestinal symptoms, which is shown in **Table 4.4**. The variables that have more participants experiencing the increased trend are 'total number of days of having bowel movements', 'total frequency of bowel movements for the past 14 days', 'discomfort or pain related to bowel activity', with 15 participants (57.69%), 16 participants (61.54%) and 13 participants (50%) respectively. The variables 'hard bowel motions', 'straining symptoms', 'urgency', 'loose, mushy or watery bowel motions' and 'diarrhoea' have more people is having no changes trend, with 15 participants (57.69%), 13 participants (50%), 12 participants (46.15%), 15 partcipants (57.69%) and 18 participants (69.23%) respectively.

Table 4.4 : Trend of number of participants to the changes of bowel activity and gastrointestinal symptoms

Variables		**Number of participants**	
	Pattern	**N**	**%**
Total number of days having bowel movements	Increased	15	57.69
	No changes	8	30.77
	Decreased	3	11.54

Table 4.4 continued: Trend of number of participants to the changes of bowel activity and gastrointestinal symptoms

Variables	Pattern	Number of participants	
		N	%
Total frequency of bowel movements for the past 14 days	Increased	16	61.54
	No changes	7	26.92
	Decreased	3	11.54
Hard bowel motions	Increased	2	7.69
	No changes	15	57.69
	Decreased	9	34.62
Straining symptoms	Increased	5	19.23
	No changes	13	50.00
	Decreased	8	30.77
Discomfort/ pain in abdomen related to bowel activity	Increased	13	50.00
	No changes	9	34.62
	Decreased	4	15.38
Urgency	Increased	11	42.31
	No changes	12	46.15
	Decreased	3	11.54
Loose, mushy or watery bowel motions	Increased	7	26.92
	No changes	15	57.69
	Decreased	4	15.38
Diarrhoea	Increased	6	23.08
	No changes	18	69.23
	Decreased	2	7.69

4.5 Effects of oat drink intervention on anthropometric measurements

The results of oat drink intervention on anthropometric measurements (body weight, BMI, waist circumference, hip-circumference, waist-hip ratio) were tabulated in **Table 4.5**. Before having oat drink intervention, 26 participants record an average body weight of 48.85 ± 7.44 kg and an average body weight of 48.91 ±7.66 kg after oat drink intervention (p = 0.6707). The average BMI initially for the participants are 19.82 ± 3.25 kg/m^2 whereas BMI of 19.84 ± 3.31 kg/m^2 is recorded after 14 days. There is a significant change in waist circumference and waist hip ratio after the intervention has been carried out. The waist circumference decreases from 70.67 ± 7.40 cm to 69.15 ± 7.31 cm (p=0.0022) whereas the waist-hip ratio declines from 0.78 ± 0.05 to 0.76 ± 0.04 after 14 days (p=0.0004). No significant changes being found in hip circumference parameter (p=0.1720).

Table 4.5: Effects of oat drink intervention on anthropometric measurements

	Pre-intervention	**Post-intervention**	**P-value**
Weight (kg)	48.85 ± 7.44	48.91 ±7.66	0.6707
BMI (kg/m^2)	19.82 ± 3.25	19.84 ± 3.31	0.6898
Waist circumference (cm)	70.67 ± 7.40	69.15 ± 7.31	0.0022 *
Hip-circumference (cm)	90.65 ± 6.08	91.33 ± 6.32	0.1720
Waist – hip ratio	0.78 ± 0.05	0.76 ± 0.04	0.0004 *

*** Significant difference when p<0.05**

For further breakdown, we analyzed the trend of number of participants to the changes of anthropometric measurements after oat drink intervention in 26 recruited participants. The data is categorized and tabulated in the following table, **Table 4.6.** There are more participants experiencing weight gain and BMI (n=14, 53.85%), decreased waist circumference (n=16, 61.54%), decreased waist-hip ratio (n=19, 73.08%) and increased hip circumference (n=18, 69.23%).

Table 4.6: Trend of number of participants to the changes of anthropometric measurements after oat drink intervention

Variables	**Trend**	**Number of participants**	
		N	**%**
Weight	Increased	14	53.85
	No changes	2	7.69
	Decreased	10	38.46
BMI	Increased	14	53.85
	No changes	2	7.69
	Decreased	10	38.46
Waist circumference	Increased	4	15.38
	No changes	6	23.08
	Decreased	16	61.54
Hip circumference	Increased	18	69.23
	No changes	1	3.85
	Decreased	7	26.92

Table 4.6 continued: Trend of number of participants to the changes of anthropometric measurements after oat drink intervention

Variables	Trend	Number of participants	
		N	%
Waist hip ratio	Increased	4	15.38
	No changes	3	11.54
	Decreased	19	73.08

4.6 Effects of oat drink intervention on fasting blood glucose and blood pressure

The changes of biochemical data (fasting blood glucose, systolic blood pressure and diastolic blood pressure) for 26 participants before giving the oat drink intervention and after giving the oat drink intervention are displayed in **Table 4.7**. Average fasting blood glucose has slightly decreased from 5.07 ± 0.39 mmol/L to 4.94 ± 0.34 mmol/L with no notable contrast (p=0.0567). Both average systolic blood pressure and diastolic blood pressure for participants marks slightly grow with data shown 98.81 ± 7.63 mmHg to 101.42 ± 8.83 mmHg (p=0.1508) and 66.77 ± 6.15 mmHg to 68.27 ± 6.09 mmHg respectively (p=0.2678).

Table 4.7 : Biochemical data before and after the oat drink intervention

	Pre-intervention	Post-intervention	P-value
Fasting blood glucose (mmol/L)	5.07 ± 0.39	4.94 ± 0.34	0.0567
Systolic blood pressure (mm/Hg)	98.81 ± 7.63	101.42 ± 8.83	0.1508

Table 4.7 continued: Biochemical data before and after the oat drink intervention

	Pre-intervention	Post-intervention	P-value
Diastolic blood pressure (mm/Hg)	66.77 ± 6.15	68.27 ± 6.09	0.2678

*** Significant difference when p<0.05**

Table 4.8 shows the trend the number of participants to the changes of biochemical data after 14 days oat drink intervention. There are higher number of participants having decreased fasting blood glucose level (n=17, 65.38%) as compared increased trend (n=7, 26.92%) and no changes trend (n=2, 7.69%). Both variables 'systolic blood pressure' and 'diastolic blood pressure' have more participants experiencing increase trend (SBP: n=16, 61.54% ; DBP: n=15, 57.69%) than no changes trend (SBP: n=3, 11.54% ; DBP: none) and decreased trend (SBP: n=7, 26.92% ; DBP: n=11, 42.31%).

Table 4.8: Trend of number of participants to the changes of biochemical data after oat drink intervention

Variables		Number of participants	
	Trend	**N**	**%**
Fasting blood glucose level	Increased	7	26.92
	No changes	2	7.69
	Decreased	17	65.38

Table 4.8 continued: Trend of number of participants to the changes of biochemical data after oat drink intervention

Variables		Number of participants	
	Trend	**N**	**%**
Systolic blood pressure	Increased	16	61.54
	No changes	3	11.54
	Decreased	7	26.92
Diastolic blood pressure	Increased	15	57.69
	No changes	0	0.00
	Decreased	11	42.31

4.7 Effects of oat drink intervention on peripheral white blood cells

Table 4.9 presents the ratio of white blood cells to 1000 of red blood cells for 26 participants before and after the oat drink intervention. In pre-oat drink intervention, the ratio of white blood cells to 1000 of red blood cells is 2.60 ± 1.29. The ratio has slightly decreased to 2.30 ± 0.70 after the participants consume oat drink for 2 weeks. However, the decreased result is not significant.

Table 4.9: White blood cells to 1000 red blood cells ratio before and after the oat drink intervention

	Pre-intervention	**Post-intervention**	**P-value**
White blood cell/1000 red blood cells ratio	**2.60 ± 1.29**	**2.30 ± 0.70**	**0.3091**

CHAPTER 5

DISCUSSION

5.1 Nutrient analysis of the commercial oat drink

In our study, we provided Quakers 3 in 1 instant oat drink to the participants. In one packet of the Quakers 3 in 1 oat drink given, there are 15 sachets of oat drink. Our participants were only needed to consume 14 sachets of oat drink during the 14-days intervention, with 1 sachet of oat drink is consumed every early morning. Each sachet provides a serving with total weight of 28g. In one serving, the Quakers 3 in 1 instant oat drink provides 116 kcal of energy, 21.0 g of carbohydrates with the addition of 9.7 g of sugars, 1.5 g of protein and 2.9 g of fats (1.8 g of saturated fatty acids, 0.7 g of monounsaturated fatty acids and 0.4 g of polyunsaturated fatty acids). Besides, Quaker's oat drink consists of 1.0 g of dietary fiber for each sachet consumed. As compared to another brand of oat drink that is available in the market, Quaker's oat drink contains more fiber. The major ingredients of this product are oats (wholegrain oat – 34.38%) , wheat, soy and milk. Besides, there is also an addition of several vitamins and minerals to improve the overall nutritional value of the product which include vitamin B9, thiamine, mononitrate, riboflavin, niacinamide, pyridoxine, HCl, folic acid, vitamin B12 and maltodextrin. Thus, in the end, we decided to use Quaker's oat drink as the intervention material to study the effects of breakfast oat drink consumption on the bowel function and health

parameters. The details of nutritional information and ingredient list of Quaker's 3 in 1 instant oat drink is shown in **Table 5.1** and **Figure 5.2** respectively.

Figure 5.1: Quaker's 3 in 1 instant oat drink.

Table 5.1: Nutritional information of Quaker's 3 in 1 instant oat drink.

Servings per pack: 15
Serving size: 28g (1sachet)

	Per 28g	**Per 100g**	**Per 100ml**
Energy (kcal)	116	415	65
Protein (g)	1.5	5.5	0.9
Total fat	2.9	10.3	1.6
Saturated fatty acids (g)	1.8	6.3	1.0
Monounsaturated fatty acids (g)	0.7	2.4	0.4
Polyunsaturated fatty acids (g)	0.4	1.5	0.2
Trans fatty acids (g)	0.0	0.0	0.0
Cholesterol (mg)	0	0	0
Carbohydrates (g)	21.0	75.1	11.8
Total sugars (g)	9.7	34.7	5.5
Dietary fiber (g)	1.0	3.7	0.6
Sodium (mg)	80	287	45
Calcium (mg)	224	800	126
Vitamin B1, Thiamin (mg)	0.2	0.7	0.1
Vitamin B2, Riboflavin (mg)	0.2	0.8	0.1
Vitamin B3, Niacin (mg)	2.5	9.0	1.4
Vitamin B6, Pyridoxine (mg)	0.3	1.1	0.2
Vitamin B9, Folic acid (µg)	54	194	31

Table 5.1 continued: Nutritional information of Quaker's 3 in 1 instant oat drink

	Per 28g	Per 100g	Per 100ml
Vitamin B12, Cobalamin (µg)	0.3	1.2	0.2
Vitamin D3 (µg)	1.3	4.7	0.7

Figure 5.2: Ingredient list of Quaker's 3 in 1 instant oat drink.

5.2 Oat drink intervention on bowel activities and constipation

In this study, we observed that there is an increase in the total average number of days for the participants in performing bowel movements and the total frequency of the bowel movements for the past 14 days. However, the elevation of total average number of days for participants to pass motion is not significant but the total frequencies for participants to have bowel movements for the last 14 days is significant when comparing the data from pre-intervention and the data for 14 days intervention. For variable 'total number of days experiencing bowel movements', there are 15 participants (57.69%) reported to have improvements, 8 participants (30.77%) reported no changes and only 3 participants (11.54%) mentioned to have

decreased result whereas for variable ‘total frequency of having bowel movements for the last 14 days’, 16 participants (61.54%) reported to have improvements, 7 participants (26.92%) reported no changes and 3 participants (11.54%) mentioned to have decreased result. A previous study from Paruzynski, et al. (2019) shows that there is no significant difference in stool frequency after giving oatmeal to the participants for consumption. A systematic review from Thies, et al. (2014) showed that most of the trials revealed that oats had no discernible impact on stool frequency.

Besides, our study shows that there is a decreased trend in the number of days for the participants experiencing hard bowel motions and the straining symptoms although it is not significant. Previous studies from Paruzynski, et al. (2019) shows that the straining symptoms have recorded improvement after 1 week of oatmeal intervention. In our study, before the intervention was carried out, an equal number of participants (13 participants, 50%) reported either having hard bowel motions or straining symptoms. From these 13 participants who had hard bowel motions and straining symptoms before the intervention, more than half of the number of participants show an enhancement in ‘hard bowel motions’ variable (9 participants, 69.23%) and straining symptom (8 participants, 61.54%) after they include oatmeal in their breakfast.

Therefore, as a summary, there is a trend portrayed by our study that the inclusion of oat drink in our daily diet could improve constipation and its symptoms. The positive effects of the oat drink on constipation improvements may be due to the interaction of oat soluble fibres and insoluble fibres, which soluble fibres comprise about 55% and insoluble fibres comprise 45% out of total fibre content in the oat (Sharma and Chawla, 2011). The interaction of almost equal percentage of soluble and insoluble fibre in the oat is crucial in producing a thick, smooth and easy to pass stool by ensuring adequate water content in the colon which promotes stool motions (McRorie and McKeown, 2016).

5.3 Oat drink intervention on bowel discomfort and diarrhea

Our studies have shown that there is a significant increase in abdominal pain symptoms and urgency symptoms with oat drink intervention and there is an increase average number of days for 26 participants to have loose, mushy or watery bowel motions and average number of days for participants to have diarrhoea, although the increase of both these variables do not show a significant difference. After consumption of instant oat drink, half of the participants were increased events of abdominal pain (13 participants, 50%), while 4 participants (15.38%) found to have decreased abdominal pain problem and 9 participants (34.62%) found out to have no difference. For urgency symptoms, only 3 participants (11.54%) are found to have decreased number of days in experiencing a rush to toilet for bowel motions, 11 participants (42.31%) are having decreased number of days in experiencing a rush to toilet for bowel motions and 12 participants (46.15%) do not

have any changes before and after including oat drink in their diet. From the result, there are two participants who have a significant increase in the changes for urgency symptoms. These two participants have an increased difference 'number of days for having urgency symptoms' by 6 days and 9 days, while the changes for number of days for experiencing urgency symptoms by the other 24 participants are in the range of 1 to 3 days. Furthermore, there are more number of participants recorded to have no difference in number of days experiencing loose, mushy or watery stools and diarrhea before and during the 14-days intervention, with 15 participants (57.69%) for variable 'loose, mushy or watery stools' and 18 participants (69.23%) for variable 'diarrhoea'.

From this study, it was observed that oat drink consumption may worsen the gastrointestinal symptoms and might cause a person to develop diarrhoea. Our findings are correlated to a study carried out by Peräaho, et al. (2014) which shows there is an increase in the number for gastrointestinal symptoms and diarrhoea reported. The possible reason to explain this is due to the presence of FODMAPs. FODMAPs is a short form for the term 'fermentable oligosaccharides, disaccharides, monosaccharides and polyols'. They are a group of short-chain carbohydrates that are less likely to be absorbed by the intestines, osmotically active, and quickly digested by gut flora. This characteristic presented by FODMAPs result in more gas generation, accumulation of fluid, discomfort and increased possibility of developing diarrhoea due to FODMAPs facilitating the water and substances movement to the upper large intestines (Kasti, et al., 2022; Barrett, 2010). Oat

consists of a smaller amount of fructans (fructo-oligosaccharides), which 100g of oat only contributes 0.1 g of fructans, which is far lesser than other cereal products such as ryes, wheat and barley (Saeed, et al., 2012). The amount of fructans present in the oat is lesser than the cut-off point, which, a person is allowed to consume 0.3 g of oligosaccharides per serving, and thus, oat can be claimed as a low-FODMAP diet (Schmidt and Sciurba, 2020). However, although oat is grouped as the low-FODMAPs food, the long-term effects of small amounts of fructans in the oat on gastrointestinal symptoms and diarrhoea is still unknown. Lis, et al. (2016) also found out that there are 29 participants are more reactive to the effects of fructans, which therefore lead to the development of gastrointestinal symptoms.

Besides, the instant 3 in 1 oatmeal that we gave to the participants include wheat flour as an ingredient, which wheat flour is rich in FODMAPs such as raffinose, nystose, ketopentose, and fructan-related oligosaccharides (Schmidt and Sciurba, 2020). This makes the total FODMAPs content in the instant oat drink given to the participants become questionable, and the effects of oat drink on gastrointestinal symptoms and diarrhoea becomes doubtful. Therefore, the oat drink consumption worsens the gastrointestinal symptoms and possibility of inducing diarrhoea due to presence of FODMAPs is needed for more clarification and further study is needed to be carried out.

In addition, the oat drink intervention increases the abdominal pain and gastrointestinal symptoms might be due to lactose intolerance from the participants. In the ingredients list on the label of the instant Quakers oat drink given to the participants, milk is included as one of the ingredients. Since the participants from our study are all come from Chinese ethnicity, we review a study from Makbul, et al. (2016) on the prevalence of Malaysian Chinese population having lactose intolerance. The prevalence of lactose intolerance among Malaysian Chinese is as much as 91% (Makbul, et al., 2016). However, more studies needed to be carried out to validate the increased of worsening gastrointestinal symptoms and diarrhoea after oat drink intervention is due to the lactose intolerance as a result of addition of milk in the product but not the rolled oat (without addition of any ingredients).

5.4 Oat drink intervention on body weight and BMI

Our result shows that there is no significant increase or decrease in body weight and BMI after oat drink intervention for 14 days. However, when analysing the numbers of participants of having body weight changes, only 2 participants (7.69%) have no change in body weight, while 10 participants (38.46%) are having reduction in body weight with a difference range from 0.1 kg to 2 kg whereas 14 participants (53.85%) are having a weight gain (increased weight difference: 0.1 – 1.9 kg). There is a decrease in both body weight and BMI for participants after giving oatmeal intervention in the research carried out by Chang, et al. (2013). The effects of oat in reducing body weight and BMI can be explained by a systemic review from Shedzad, et al. (2023), which summarises that oat consumption is able

to promote weight reduction is mainly due to the alteration and changes in the hormones level that regulate the satiation such as leptin, glucagon-like peptide-1 (GLP-1) and peptide tyrosine tyrosine (PYY).

The result and the explanation from both Chang, et al. (2013) and Shedzad, et al. (2023) are contradicted with our results which show no significant changes on body weight and BMI after oat drink is given to the participants but increase total number of participants to have small weight gain after 14-days oat drink intervention. The possible reason that might explain no significant increase or decrease in body weight is due to the short duration for our study, which only involves 2 weeks. The changes of body weight need time to see the differences. According to the rule of thumb for body weight changes, a change in the total calorie consumption of 3500 kcal will lead to a change of body weight by 0.45 kg. Therefore, to summarise, for a person who wishes to have a change of body weight by 0.45 kg in a week, he or she needs to increase or decrease the total calorie intake in one day by 500 kcal. (Mayo Clinic, 2023).

The possible inference made for the increased number of participants to have weight gain is due to the dietary pattern of the participants. In our study, during the intervention week, the participants are asked to follow their usual diet without restricting any food intake. From the diet record, during breakfast time, most of the participants only take instant oat drink that we gave to them as their only food

choice without having other food consumption during the 14-days intervention week. Therefore, we assume that these participants do not have the habits of eating breakfast before intervention is carried out. 14-days intervention encourages the participants to increase the number of meals by one meal, which is breakfast, with the consumption of oat drink. For those who have the habits of breakfast intake, addition of a sachet of oat drink in their diet will increase their total calories. The instant oat drink given to the participants contributes calorie, in which 1 serving (1 sachet) provides 116 kcal. In 2 weeks, the total calories provided by the oat drink given to the participants is 1624 kcal, which is far lesser than the rule of thumb for weight changes. Thus, the small calories provided by the oat drink during breakfast promotes small and not significant weight gain for the participants, with the percentage of average weight gain of only 0.12%.

5.5 Oat drink intervention on waist circumference and waist-hip ratio

Although there is no significant difference in the changes of the body weight, yet our results show that there is a significant decline in the waist circumference and waist-hip ratio after oat drink intervention for 2 weeks. Waist circumference measurement is used as an indicator for the possibility of central obesity, which means there is an accumulation of fat in the organs at the abdominal part. High visceral fat is the risk factors for metabolic syndrome, high blood pressure, failure of organs to react with insulin, Type-2 diabetes mellitus, cardiovascular disease and cancers (Habibzadeh, 2020). A study from O'Neil (2015) revealed that oatmeal consumption is found to reduce the risk for central obesity development, with a

reduction in waist circumference (O'Neil, 2015). Chang, et al. (2013) has similar findings in which oat consumption for 12 weeks can attenuate abdominal fat deposition.

The possible reason for the positive relationship between oat consumption and reduced central obesity as oat influences and affects the lipid metabolism. A study carried out by Gao, et al. (2015) carried out a study on the possible interaction between oat consumption with intestinal fat by using a *Caenorhabditis elegans* (*C. elegans)* model. *C. elegans* is a multicellular eukaryotic organism, which most of the genes are found to link with human diseases and suggested to be used in obesity studies. From Gao, et al. (2015), less intestinal fat deposition is found in all strains of *C. elegans* being studied. There is an increase of *cpt-1* and *cpt-2* genes being expressed in wild-type *C. elegans* (N strains). The positive expression of *cpt-1* and *cpt-2* genes promotes lipid ß-oxidation and turnover, which therefore reduce fat being deposited at the intestinal. In our body, fats are stored as triglycerides in our adipose tissue. The triglycerides will be broken down into fatty acids and glycerol. Fatty acids are used for the production of energy via ß-oxidation (Fillmore, Alrob, and Lopaschuk, n.d.; Edward and Mohiuddin, 2023). Therefore, increase in ß-oxidation means more fatty acids are needed for energy production, leading to more fat stores are broken down to produce free fatty acids. Therefore, there will be less fat being accumulated and deposited in the adipose tissue, especially in the abdominal part.

5.6 Oat drink intervention on blood glucose level

Our study shows that there is a minor decrease in the blood glucose level of the participants with normal blood glucose level after 14-days oat drink intervention, although the decline is not significant. However, when we investigate the number of participants on the changes of blood glucose level after oatmeal consumption, we found out that there are as much as 17 participants (65.38%) to have decreased fasting blood glucose level, while 7 participants (26.92%) have increased fasting blood glucose level and only two participants (7.69%) have no fasting blood glucose level alteration after 14 days of oat drink intervention. Previous study from Barati, et al. (2021) and Pino, Mujica and Arredondo (2021) shows a significant decrease in blood glucose level and enhancement of the condition for disease-centered patients, those who are having gestational diabetes or Type-II diabetes after the intervention.

The effect of oat drink intervention reduces blood glucose level can be explained by the relationship between oat and the hormone changes. Oat drink consumption promotes the production of adiponectin hormone in the blood, which raises the insulin hormone in the blood, which is essential for lowering blood glucose levels (Lammert, 2007; Nguyen, 2020). Since the participants that we recruited are female university students with age 18 – 25 years old and they are healthy individual, their blood glucose levels in the body are well regulated by two hormones which are insulin and glucagon. Due to the normal functioning of both hormone, we can only observe a minor differences in the blood glucose level after giving them oat drink

intervention. Thus, to study the relationship between oat drink and blood glucose level in healthy individuals, the study of postprandial blood glucose is more suitable to identify whether the oat drink intake will lead to a spike in blood glucose level. Continuous maintaining high level of postprandial blood glucose may direct us to develop of insulin resistance, which our body cell fails to react or less sensitive to the insulin being synthesised by our pancreas (Rousell, Huynh and Joseph, 2021).

Based on the above discussion, the results shown the consumption of oat drink may have a trend in improving blood glucose profile for a short-term duration. However, the long-term effects of consuming the oat drink on blood glucose profile is questionable due to the addition of sugar to the product during processing. According to the Dietary Guidelines of Americans, a person with a mean calorie intake of 2000 calories per day is suggested to only take 50 g of added sugar in a day. A product with added sugar more than 20% DV will be considered as food riches in added sugar (Harvard T.H. Chan, 2022). From the nutrition label of Quaker's 3 in 1 oat drink that we provided to the participants, it consists of 9.7 g of added sugar. After calculation based on the maximum tolerable sugar intake in a day from Dietary Guidelines of Americans, the DV percentage for Quaker's 3 in 1 oat drink is 19.4%. Although the DV percentage of the Quaker's oat drink is still not yet to be classified under product riches in high added sugar, the high DV percentage which near to the cut-off point may arise the worries of the consumers on the long-term effects of oat drink consumption on the blood glucose level and the risk of developing Type-II diabetes mellitus. Thus, further research is required

to be carried out to study the long-term effects of consumption Quaker's oat drink which has high DV percentage due to the added sugar and other 3-in-1 instant oat drink brand on the blood glucose profile.

5.7 Oat drink intervention on blood pressure

Our result shows that there is no significant difference in systolic blood pressure and diastolic blood pressure in pre and post oat drink intervention. However, the data shows both systolic and diastolic blood pressure has slightly increased over the 14 days intervention. The number of participants experiencing increased blood pressure for both systolic and diastolic blood pressure are 16 participants (61.54%) and 15 participants (57.69%) respectively. These data are contradicted with some studies, indicating oatmeal consumption cause a decline in blood pressure and the claims that oatmeal is a favourite food item for cardiovascular disease patient (Keenan, et al., 2002; Xue, et al., 2021).

However, dietary intake is not the only reason that will influence the blood pressure, but there are still a lot of factors should be taken into considerations. One of the considerations that will cause high blood pressure is irregular sleeping time and poor sleeping pattern. A person who has a sleeping time below 6 hours is found to increase the risk of developing high blood pressure. Besides, when comparing those who adhered to a normal bedtime with those who have irregular bedtime, 92% higher risk for a person to develop high blood pressure if there is a change of 90

minutes or more of the sleeping duration. Individuals will have a 32% higher risk of being diagnosed with hypertension even with fluctuations in sleeping length every night that are only little longer than 30 minutes (Williamson and American Heart Association News, 2023). The findings from Culver, et al. (2022) found out that sleep irregularity is the most direct root in increasing blood pressure in young adults. The possible reason for the participants to have poor sleeping pattern may be due to the stress they experienced. Our study is carried out in week 4 and week 5 of the study week. During this period, most of the mid-term test or quiz will be carried out in UTAR. With the heavy workload due to the assignments and the midterm tests, the stress level of the participants might increase, which causes them to have poor sleeping experience. Campbell, et al. (2018) found out that university students tend to have stress and poor sleeping experience during exam weeks.

5.8 Oat drink intervention on white blood cells counts

Previous study shows that oatmeal intervention has the impact on the microbiota composition, with a specifically elevation of Firmicutes phylum but drop of Bacteroides and Proteobacteria phylum (Ye, et al., 2020). The changes of the microbiota composition in the gut are expected to bring an impact in the immune response of the mucosal GALT. However, our result shows there are no significant changes on the ratio of white blood cells count to 1000 of red blood cells after giving oat drink intervention for 14 days. This result gives an idea in which oat drink consumption does not promote inflammation nor reduce inflammation. However, our result cannot truly reflect the real effects of oat drink consumption

on the number of white blood cells and its effects on inflammation due to the methods that we used for cell counting. In our study, we conducted a manual cell counting to estimate the number of white blood cells and number of red blood cells by looking through the blood smear under the optical microscope, which was later used to calculate the estimated ratio of white blood cells to red blood cells. The estimation method by using manual cell counting is prone to error, which the range of error can go up to 20% to 30% (Electron Microscopy Sciences, n.d.). The possible reasons for the error in manual counting is due to the failure to differentiate white blood cells and platelets and poor blood smear quality as a result of improper blood smear technique and blood staining method. Furthermore, due to the significant variations in precision between individuals, which range from 21.0% to 35.9%, the validity of manual counting is questioned (Jonge, et al., 2004).

5.9 Limitations of the study

Most of the findings from our study indicated that there were no appreciable changes in the parameters under investigation. A pilot study, with the recruitment of only 26 participants in our study (small sample size) may be the cause for the lack of any discernible changes of the results. Pilot study with small sample size used cannot accurately represent all female students at UTAR Kampar. Additionally, when a small sample size is being employed, type II error is more likely to occur. Small sample size also cannot detect the small differences of the data being studied. In our study, although there is no significant difference in the parameters shown after statistical analysis, there are minor changes in some

parameters such as in ‘loose, mushy, watery bowel motions’, ‘diarrhoea’, ‘fasting blood glucose’ and etc.

Next, the possible reason for the not significant changes of oat drink intervention in most of the parameters studied is due to the short duration of the research, which is only 2 weeks. Diet interaction with the body metabolism needs time to show the changes. For instance, for weight management, a calorie change of 500 kcal/day consistently can only change 0.9 kg of body weight in 2 weeks. Furthermore, our studies focus on the healthy female individual, which has the normal healthy body regulation system, thus, short duration intervention is less likely to disrupt the normal healthy body regulation system.

In addition, overreported and underreported are one of the limitations of our study. In our study, we ask the participants to recall their bowel activity and the gastrointestinal symptoms they had experienced for the past 14 days before the intervention. The participants may not remember all the bowel activity in the past 14 days and therefore the data collected by using the questionnaire is only an estimation. Besides, overreported and underreported limitation can also be seen while we determine the dietary pattern of the participants. In our study, we ask the participants to record the food they have eaten and the portion sizes during 14-days intervention by themselves. Although the guidelines of the portion sizes have been attached in the food diary, the participants may still confuse, leading to the

inaccurate record of the portion sizes of each food they have eaten. The inappropriate record of the portion size makes us unable to determine the calories and nutrients of the participants consumed in one day, and thus, we are unable to investigate the relationship between the diet and the effects of oat drink intervention on bowel function and health parameters in more details.

Lastly, in our study on the effect of oat drink consumption on white blood cell counts, the method that we used to perform white blood cell counts are prone to error. During cell counting under the optical microscope, we found out some overlapping of the cells and some cells are not stained well. Overestimation and underestimation are more likely to occur due to the presence of these two factors. Besides, since we perform blood smear, there is uneven distribution of the cells on the slide, which some parts perform to have high density of cells accumulation whereas some areas will have less density of cells accumulation. The uneven cell distribution on the slide leads us to have false predictions for the white blood cell to red blood cell ratio.

5.10 Recommendations for future study

In future, we recommend carrying out a similar study by using the randomized controlled trial to study the effects of oat drink intervention on bowel function and health parameters. Before the intervention, we suggest having a washout period for 14 days. During these 14 days, no intervention will be given to the participants. The

participants are required to fill in the bowel diary which include the frequency of bowel movement and gastrointestinal symptoms questions during the 14-days washout period. In the last 3 days of the washout period, the researchers may use 24-hour dietary recall to obtain the dietary pattern of the participants. After the washout period, the oat drink intervention will be given to the participants. The bowel activity pattern and dietary pattern of the participants are obtained via the same method as during the washout period. After 2 weeks of the intervention, the researcher may have a follow up session with the participants. All the data collected are then analysed by categorising into pre-intervention, mid-intervention and post intervention.

For further study on the effects of oat drink intervention on the blood glucose level of female healthy individual, the researchers can carry out an intervention by investigating the postprandial blood glucose level of the participants. The purpose of carrying out this intervention is to find out the relationship of oat drink consumption with the insulin resistance of female healthy individual. To carry out this intervention, at first, the blood glucose level of the participants will be measured. An oat drink product will be given to the participants after the blood glucose level before the intervention is taken. The blood glucose level of the participants will be taken again at 30 minutes and 1 hour after the participants have consumed the oat drink. During this 1 hour, the participants are not allowed to consume any other food and recommend avoiding strenuous physical activity. The

blood glucose level of the participants at fast, 30 minutes, 1 hour will be recorded down and analysed.

For the study on the effects of oat drink consumption on the inflammation and the gut immune response, the researchers are suggested to complete a complete blood cell counts by using hematology analyzer, which will produce more accurate and reliable results. The inflammation status of the participants can also be determined by measuring the C-creative protein level of the participants. In future study, the researchers can investigate the relationship between the oat drink consumption with microbiota changes and inflammatory status. The researchers can collect the stool sample of the participants before and after the intervention to determine and investigate whether the oat drink consumption will lead to the changes of the microbiota composition. By study the effects of oat drink consumption on microbiota composition, the researchers can then relate and investigate the microbiota composition changes to the inflammatory status of the participants.

Lastly, as mentioned, our study is a pilot intervention study, and the limitation of the current study is short duration. Therefore, in future, we suggest carrying out an intervention by using a bigger sample size and long duration. Bigger sample size used can detect and validate the small changes of the results after oat drink intervention. Additionally, a larger sample size will be more representative of all UTAR-based female university students. Longer duration of study is to determine

the long-term effects of the oat drink consumption on the bowel function and the health parameters.

CHAPTER 6

CONCLUSION

In conclusion, in this study, the oat drink consumption possesses a health benefit towards bowel function and health parameters in UTAR Kampar female university students. Breakfast oat drink intervention shows a trend in relieving constipation and its symptoms with a significant increase in the total frequencies for participants to have bowel movements for the last 14 days and a trend of increase for the participants to experience increased total number of days for participants having bowel movements, decreased number of days having 'hard bowel motions' and straining symptoms. Therefore, we proposed that oat drink can be suggested to the people who suffered from constipation. Besides, oat drink is not a good food choice for the people who had diarrhea. Our results shown that breakfast oat drink intervention may worsen the abdominal pain and increase the likelihood for a person to develop diarrhea. Furthermore, our studies show there is a significant decrease in waist circumference and waist-hip ratio after 14 days of breakfast oat drink intervention, which may indicate that oat drink consumption can help a person, especially for those who are overweight and obese, to have a better weight management. However, the queries on the effectiveness of oat drink consumption in weight management appears when there are no significant weight changes and there are more participants experiencing weight gain after 14-days intervention.

Further studies are required to be carried out to clarify this contradictory result. In addition, this study gives an idea that oat drink consumption may help us to have a better glycemic management and having less risk in developing insulin resistance as the results show there is a trend of decrease of blood glucose level although the result is not significant and there are higher number of participants to have decreased blood glucose level after 14 days of oat drink intervention. Blood pressure, both systolic and diastolic, show a trend of increase after oat drink intervention, as reported in this study, which is contradicted to the previous study. Further studies are needed to clarify whether the increased results are due to the effects of oat drink or possibly due to other reasons. Lastly, limitation in the method used for white blood cells count, proposed a result that oat drink consumption does not promote inflammation nor reduce inflammation from our studies. Due to the weakness of the method used, further research needs to be studied by using a more reliable and accurate cell counting method. For future study, we recommend conducting a randomized controlled trial which include large sample size and long duration in order to explore the long-term effects of oat drink consumption and to be more representative of all UTAR female university students.

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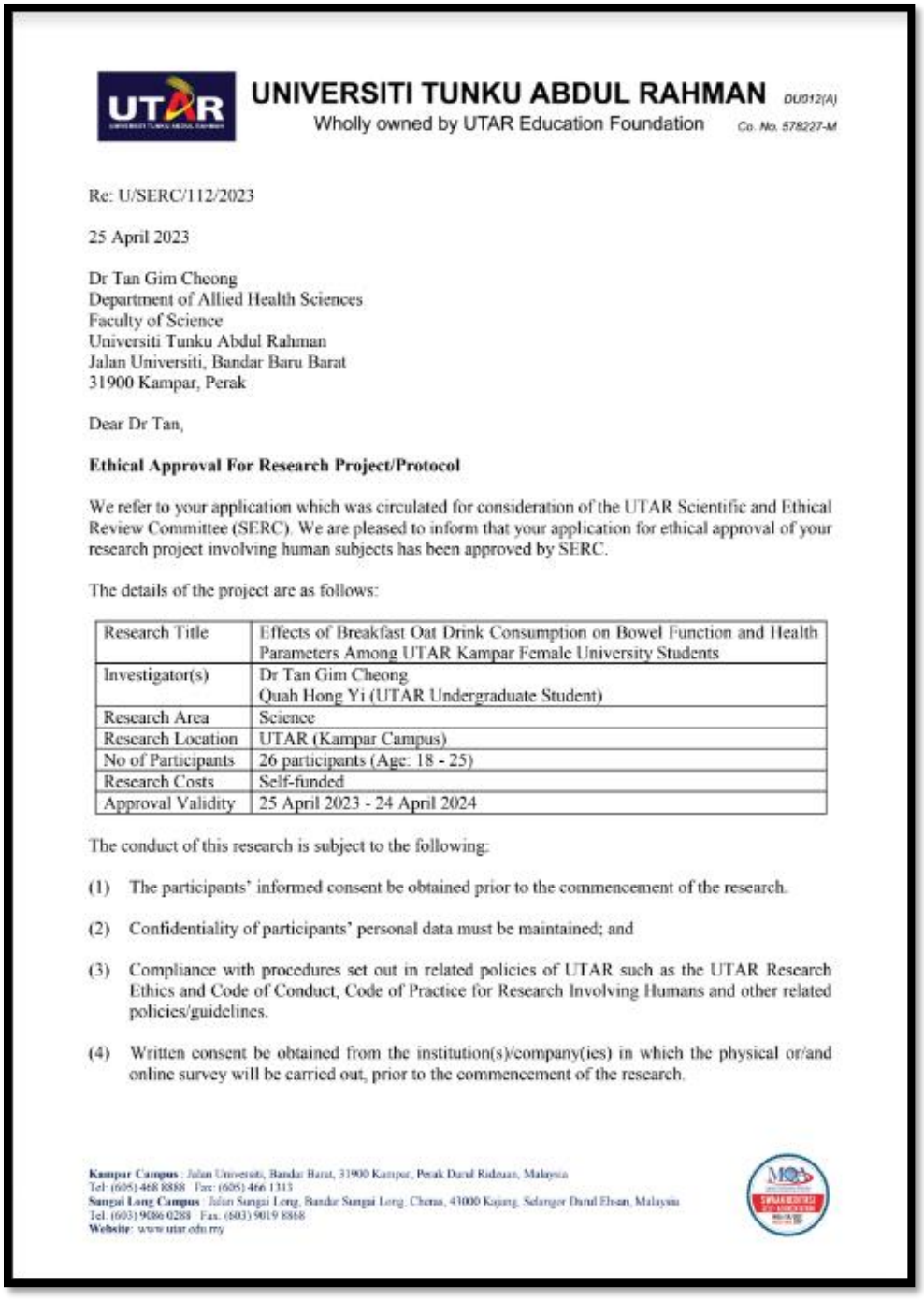
Appendix A

The ethical approval form



UNIVERSITI TUNKU ABDUL RAHMAN DU012(A)
Wholly owned by UTAR Education Foundation Co. No. 578227-M

Re: U/SERC/112/2023

25 April 2023

Dr Tan Gim Cheong
Department of Allied Health Sciences
Faculty of Science
Universiti Tunku Abdul Rahman
Jalan Universiti, Bandar Baru Barat
31900 Kampar, Perak

Dear Dr Tan,

Ethical Approval For Research Project/Protocol

We refer to your application which was circulated for consideration of the UTAR Scientific and Ethical Review Committee (SERC). We are pleased to inform that your application for ethical approval of your research project involving human subjects has been approved by SERC.

The details of the project are as follows:

Research Title	Effects of Breakfast Oat Drink Consumption on Bowel Function and Health Parameters Among UTAR Kampar Female University Students
Investigator(s)	Dr Tan Gim Cheong Quah Hong Yi (UTAR Undergraduate Student)
Research Area	Science
Research Location	UTAR (Kampar Campus)
No of Participants	26 participants (Age: 18 - 25)
Research Costs	Self-funded
Approval Validity	25 April 2023 - 24 April 2024

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research.

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Kampar Campus : Jalan Universiti, Bandar Baru, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 Fax: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 Fax: (603) 9019 8868
Website: www.utar.edu.my

Appendix A (continuous)

The ethical approval form (continuous)

Should you collect personal data of participants in your study, please have the participants in the research signed the attached Personal Data Protection Statement for your records.

The University wishes you all the best in your research.

Thank you.

Yours sincerely,

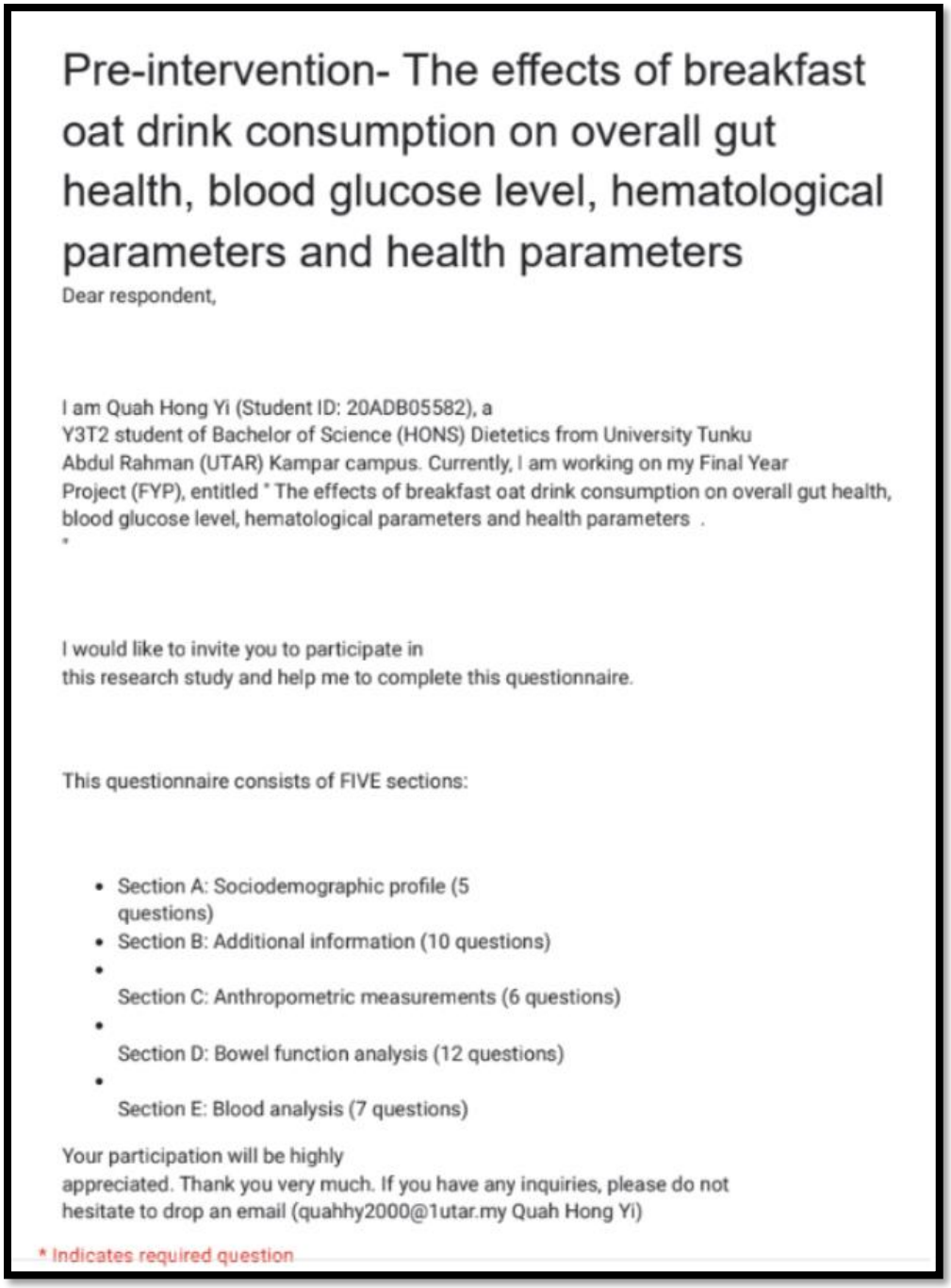
Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, Faculty of Science
Director, Institute of Postgraduate Studies and Research

Kampar Campus : Jalan Universiti, Bandar Barat, 31900 Kampar, Perak Darul Ridzuan, Malaysia
Tel: (605) 468 8888 Fax: (605) 466 1313
Sungai Long Campus : Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor Darul Ehsan, Malaysia
Tel: (603) 9086 0288 Fax: (603) 9019 8868
Website: www.utar.edu.my

Appendix B

Questionnaire



Pre-intervention- The effects of breakfast oat drink consumption on overall gut health, blood glucose level, hematological parameters and health parameters

Dear respondent,

I am Quah Hong Yi (Student ID: 20ADB05582), a Y3T2 student of Bachelor of Science (HONS) Dietetics from University Tunku Abdul Rahman (UTAR) Kampar campus. Currently, I am working on my Final Year Project (FYP), entitled " The effects of breakfast oat drink consumption on overall gut health, blood glucose level, hematological parameters and health parameters .
"

I would like to invite you to participate in this research study and help me to complete this questionnaire.

This questionnaire consists of FIVE sections:

- Section A: Sociodemographic profile (5 questions)
- Section B: Additional information (10 questions)
- Section C: Anthropometric measurements (6 questions)
- Section D: Bowel function analysis (12 questions)
- Section E: Blood analysis (7 questions)

Your participation will be highly appreciated. Thank you very much. If you have any inquiries, please do not hesitate to drop an email (quahhy2000@1utar.my Quah Hong Yi)

* Indicates required question

Appendix B (continuous)

Questionnaire (continuous)

Sociodemographic profile

1. Name (Eg: Quah Hong Yi) *

_____

2. Age (Eg: 22) *

_____

3. Ethnicity *

Mark only one oval.

- ◯ Malay
- ◯ Chinese
- ◯ Indian
- ◯ Other: _____

4. Field of study (Eg: Dietetics) *

_____

5. Year of study (Eg: Y3S2) *

_____

Additional information

Appendix B (continuous)

Questionnaire (continuous)

6. Do you take any fiber supplements?

Mark only one oval.

- ◯ Yes
- ◯ No

7. Do you take any laxatives medications to improve bowel function?

Mark only one oval.

- ◯ Yes
- ◯ No

8. Do you undergo any medical therapy?

Mark only one oval.

- ◯ Yes
- ◯ No

9. Do you take oatmeal as breakfast every morning? *

Mark only one oval.

- ◯ Yes
- ◯ No

10. Do you have any underlying diseases? If yes, please specify. *

_____

Appendix B (continuous)

Questionnaire (continuous)

11. Do you have allergic reaction to any food? *

Mark only one oval.

- Yes
- No

12. Does any of your family members are having diabetes mellitus? *

Mark only one oval.

- Yes
- No

13. Does any of your family members are having cardiovascular diseases? *

Mark only one oval.

- Yes
- No

14. Does any of your family members are having obesity? *

Mark only one oval.

- Yes
- No

15. Does any of your family members are having anemia? *

Mark only one oval.

- Yes
- No

Appendix B (continuous)

Questionnaire (continuous)

Anthropometric measurements

16. Height *

17. Weight *

18. BMI *

19. Hip circumference *

20. Waist circumference *

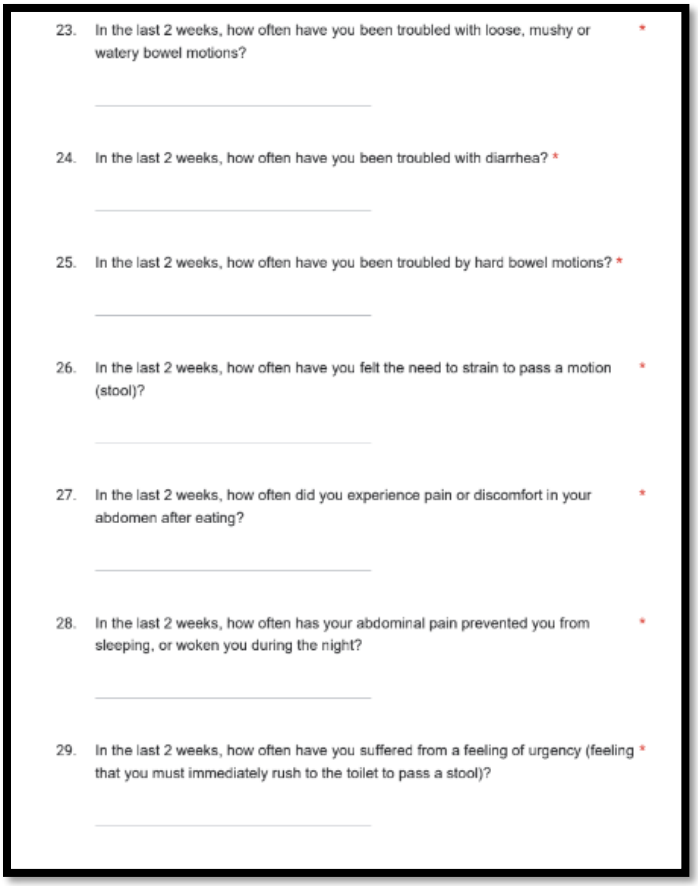
21. Hip-waist ratio *

Bowel function analysis

22. In the last 2 weeks, how often have you had discomfort or pain in your abdomen that is not related to menstrual pain? *

Appendix B (continuous)

Questionnaire (continuous)



23. In the last 2 weeks, how often have you been troubled with loose, mushy or watery bowel motions? *

24. In the last 2 weeks, how often have you been troubled with diarrhea? *

25. In the last 2 weeks, how often have you been troubled by hard bowel motions? *

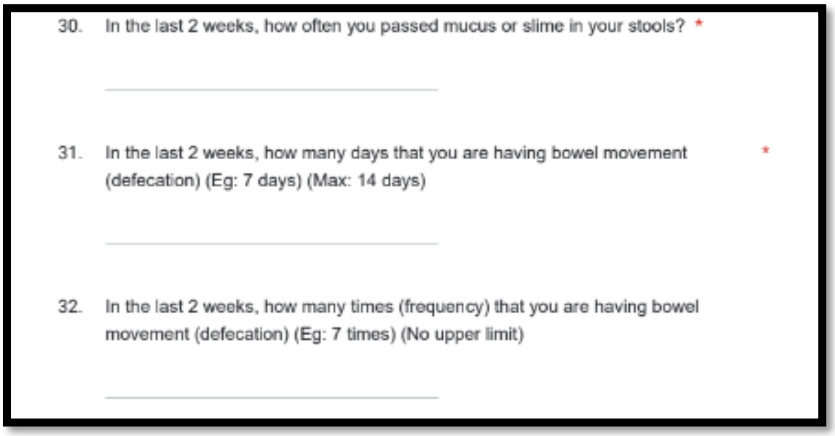
26. In the last 2 weeks, how often have you felt the need to strain to pass a motion (stool)? *

27. In the last 2 weeks, how often did you experience pain or discomfort in your abdomen after eating? *

28. In the last 2 weeks, how often has your abdominal pain prevented you from sleeping, or woken you during the night? *

29. In the last 2 weeks, how often have you suffered from a feeling of urgency (feeling that you must immediately rush to the toilet to pass a stool)? *

Questionnaire (continuous)



30. In the last 2 weeks, how often you passed mucus or slime in your stools? *

31. In the last 2 weeks, how many days that you are having bowel movement (defecation) (Eg: 7 days) (Max: 14 days) *

32. In the last 2 weeks, how many times (frequency) that you are having bowel movement (defecation) (Eg: 7 times) (No upper limit)

Appendix B (continuous)

Questionnaire (continuous)

33. Based on Bristol Stool Chart (shown in the diagram below), in the last 2 weeks, how are your stools looking like? *

Type 1	Separate hard lumps	SEVERE CONSTIPATION
Type 2	Lumpy and sausage like	MILD CONSTIPATION
Type 3	A sausage shape with cracks in the surface	NORMAL
Type 4	Like a smooth, soft sausage or snake	NORMAL
Type 5	Soft blobs with clear-cut edges	LACKING FIBRE
Type 6	Mushy consistency with ragged edges	MILD DIARRHEA
Type 7	Liquid consistency with no solid pieces	SEVERE DIARRHEA

Mark only one oval.

- ◯ Type I
- ◯ Type II
- ◯ Type III
- ◯ Type IV
- ◯ Type V
- ◯ Type VI
- ◯ Type VII

Blood analysis

34. Blood glucose level *

35. Blood pressure *

Questionnaire (continuous)

36. Red blood cell count *

37. Blood film analysis *

Appendix C

Bowel diary

Bowel diary

Name:

Date: Day 1

I woke up at:

I went to sleep at:

Time	(√) For each bowel movement	Bowel urgency? Rate 1 mild – 3 strong	Any pains or discomfort? Rate 1 mild - 3 strong	Stool type (use the Bristol Stool Form Scale on appendix)
12 am				
1 am				
2 am				
3 am				
4 am				
5 am				
6 am				
7 am				
8 am				
9 am				
10 am				
11 am				
12 pm				
1 pm				
2 pm				
3 pm				
4 pm				
5 pm				
6 pm				
7 pm				
8 pm				
9 pm				
10 pm				
11 pm				

Appendix D

Food diary

Food diary

Name:

Date: Day 1

Breakfast	
Types of food	**Portion**
Morning Tea	
Types of food	**Portion**
Lunch	
Types of food	**Portion**

Appendix D (continuous)

Food diary (continuous)

Afternoon Tea	
Types of food	**Portion**
Dinner	
Types of food	**Portion**
Supper	
Types of food	**Portion**

Appendix D (continuous)

Food diary (continuous)

Appendix

A. CAWAN, KOLE DAN GELAS
CUPS, MUGS AND GLASSES

150ml 280ml 200ml 350ml 300ml 300ml 250ml 200ml 200ml

B. SUDU DAN SENDUK
SPOONS AND LADLES

Sudu teh *Tea spoon* 5ml	Sudu makan *Dessert spoon* 10ml	Sudu sup *Soup spoon* 10ml	Senduk nasi *Rice scoop* 30ml	Senduk nasi *Rice scoop* 15ml	Senduk *Ladle* 80ml	Sudu cina *Chinese scoop* 20ml

Appendix D (continuous)

Food diary (continuous)

C. PINGGAN DAN MANGKUK
PLATES AND BOWLS

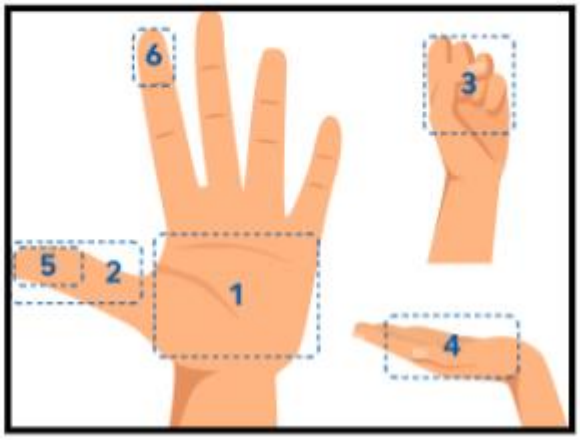
Piring kuih *Side plate* D=19.5cm	Pinggan makan *Plate* D=27.5cm	Mangkuk *Bowl* D=20cm

Piring sos *Sauce plate* D=9.5cm	Mangkuk cina kecil *Small chinese bowl* D=9cm V=150ml	Mangkuk cina sederhana *Medium chinese bowl* D=11cm V=250ml	Mangkuk cina besar *Large chinese bowl* D=13cm V=450ml

NOTA: D = Diameter
V = Isipadu (Volume)

Appendix D (continuous)

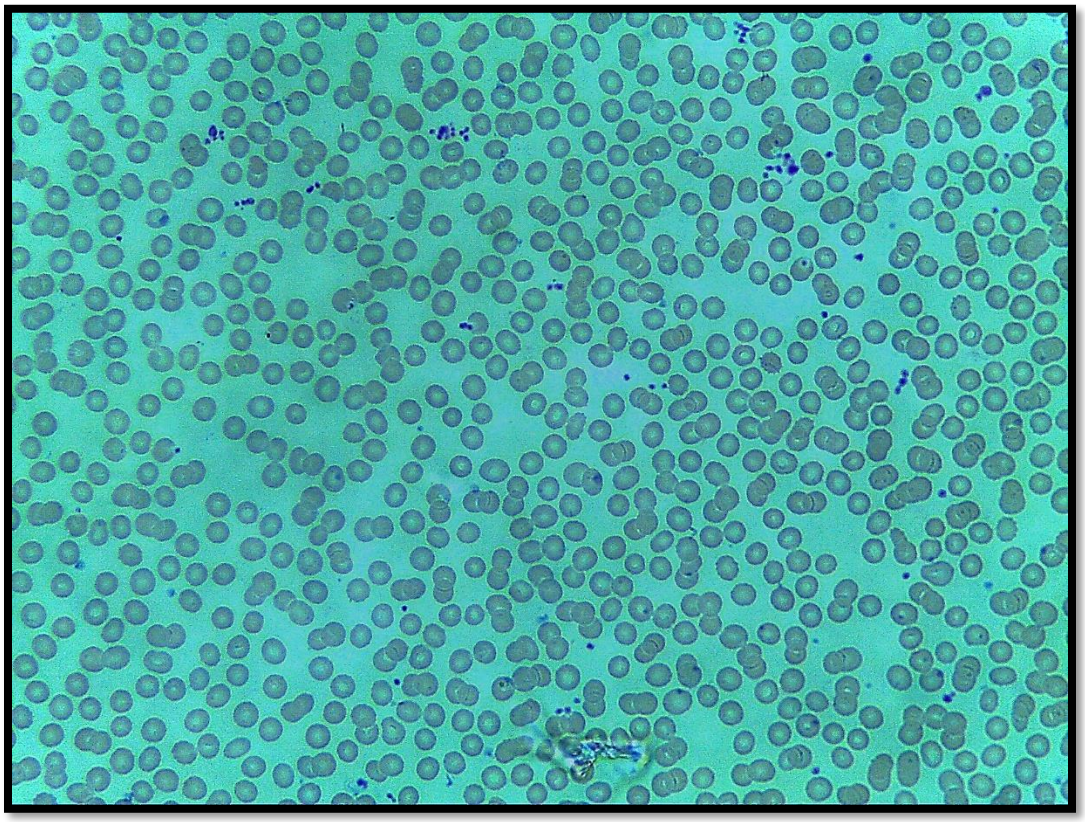
Food diary (continuous)



1. **3 ex. (85g) of meat, fish and poultry**
   = Hand palm
2. **1 ex. (28g) of meat/cheese**
   = Thumb (tip to base)
3. **1 medium fruits**
   = A fist size
4. **28g to 56g of nuts**
   = A cupped-hand size
5. **1 tablespoon**
   = Thumb-tip size (tip to first joint)
6. **1 teaspoon**
   = Fingertip size (tip to first joint)

Appendix E

Example of blood smear view under optical microscope
(This is the sample of blood smear from Elisa taken using LAS EZ)



Appendix F

Raw data of sociodemographic profile of 26 participants

Name	Age	Birth date	Ethnicity	Field of study	Year of study
Elisa Bong Tsyr Yin	23	7-Oct-99	C	DT	Y3S2
Chen Yu Wei	22	4-Aug-01	C	DT	Y3S3
Aw Xin Yin	22	4-Aug-00	C	DT	Y3S2
Ngan Tung En	19	8-Dec-03	C	Food science	Y2S1
Chin Hui Xin	20	14-Jan-03	C	Food science	Y2S1
Fong Gui Ying	23	8-Mar-00	C	Microbiology	Y1S3
Kiat Qiao Ru	22	21-Feb-00	C	Commerce accounting	Y4S1
Ong May Qian	22	28-Mar-01	C	MB	Y2S3
Foo Sze Ting	22	10-Feb-01	C	DT	Y3S2
Siew Fei Kie	22	10-Feb-01	C	DT	Y3S3
Wong En Li	21	15-Oct-01	C	DT	Y3S3
Eunice Ng Yan Ling	20	24-Mar-03	C	Financial economic	Y1S3
Esther Lau Sin Wee	21	28-Feb-02	C	Financial economic	Y1S3
Chua Xue Lin	20	22-Mar-03	C	Financial economic	Y1S2
Yap Mei Teng	22	4-Jun-01	C	DT	Y3S3
Wong Siew Ching	22	26-Mar-01	C	DT	Y3S3
Cheah Xing Ling	22	8-Feb-01	C	DT	Y3S3
Lai Pei Leng Echell	22		C	DT	Y3S3
Ong Xuan	22	16-Jan-01	C	DT	Y3S3
Lock Yee Sin	23	21-Apr-00	C	DT	Y3S3
Soon Hui Yi	22	8-Mar-01	C	DT	Y3S3
Lui Xin Yun	24	2-Jun-99	C	DT	Y3S2
Cheryl Ng Ern Xin	19	16-Dec-03	C	Bussiness of information system	Y1S2
Yap Yee Von	22	28-Feb-01	C	DT	Y3S2
Oo Xing Joe	22	3-Aug-00	C	DT	Y3S3
Kam Min Yi	22	21-Jun-23	C	Computer Science	Y4S1

Raw data of health parameters of 26 participants before and after the intervention

		Weight		BMI		Hip		Waist		Waist hip ratio		FBS		BP			
Name	Height	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Elisa Bong Tsyr Yin	1.58	50.8	51.7	20.35	20.71	91	93	64	65	0.70	0.70	5.00	5.10	94	96	63	57
Chen Yu Wei	1.58	36.9	37.1	14.78	14.86	77	79.5	60	58	0.78	0.73	5.00	4.60	117	96	82	70
Aw Xin Yin	1.51	37.3	37.3	16.36	16.36	84	84	60	62	0.71	0.74	4.60	4.50	109	92	71	75
Ngan Tung En	1.55	57.8	59.7	24.06	24.85	99	100	80	78	0.81	0.78	5.10	5.10	98	108	63	73
Chin Hui Xin	1.58	46.6	46.9	18.67	18.79	90	88.5	73.5	67	0.82	0.76	5.30	5.10	104	107	72	66
Fong Gui Ying	1.56	62.2	62.9	25.56	25.85	99	100	82	82	0.83	0.82	5.90	5.80	115	123	73	69
Kiat Qiao Ru	1.6	54.3	54.2	21.21	21.17	98	99.5	72	74	0.73	0.74	5.90	5.10	107	108	78	76
Ong May Qian	1.6	65.9	66.9	25.74	26.13	101.5	103	80	81	0.79	0.79	5.20	5.70	94	114	61	71
Foo Sze Ting	1.56	49.7	49.1	20.42	20.18	93	94	75	74.5	0.81	0.79	4.90	4.70	97	89	68	63
Siew Fei Kie	1.67	45.6	46.3	16.35	16.60	86	87.5	65	62	0.76	0.71	4.70	4.70	91	90	59	61
Wong En Li	1.54	39.8	39.2	16.78	16.53	84	77.5	58	56	0.69	0.72	4.70	5.00	94	93	65	59
Eunice Ng Yan Ling	1.55	37.4	37.5	15.57	15.61	84	89	62	60	0.74	0.67	5.10	4.70	86	104	63	80
Esther Lau Sin Wee	1.53	49.4	47.4	21.10	20.25	89	90.5	65	64.5	0.73	0.71	5.50	4.90	102	109	56	65
Chua Xue Lin	1.55	51.2	51	21.31	21.23	91	95.5	74	74	0.81	0.77	5.50	5.70	98	102	67	64
Yap Mei Teng	1.53	62.6	61.8	26.74	26.40	101	97.5	85	81	0.84	0.83	5.00	5.10	98	98	61	64
Wong Siew Ching	1.61	44.9	44.2	17.32	17.05	84	86.5	59	59	0.70	0.68	4.50	4.70	100	106	64	75
Cheah Xing Ling	1.61	44.3	43.9	17.09	16.94	86	85	70	65	0.81	0.76	4.90	4.80	86	93	61	62
Lai Pei Leng Echell	1.59	50.3	50.4	19.90	19.94	94	96.5	78	78	0.83	0.81	5.10	5.00	101	101	73	69
Ong Xuan	1.47	51.6	51.6	23.88	23.88	94	95	75	75	0.80	0.79	4.90	4.70	106	117	68	78
Lock Yee Sin	1.55	39.4	39.2	16.40	16.32	82.5	81.5	66	66	0.80	0.81	4.80	4.60	96	96	65	68
Soon Hui Yi	1.59	50.4	50.2	19.94	19.86	96	93.5	71	69	0.74	0.74	5.70	5.00	93	101	63	64
Lui Xin Yun	1.65	45	45.1	16.53	16.57	89	90.5	67	66	0.75	0.73	4.90	4.70	89	91	59	63
Cheryl Ng Ern Xin	1.56	48.1	48.3	19.76	19.85	91	91.5	75	69	0.82	0.75	5.50	5.10	99	98	74	72
Yap Yee Von	1.54	49	49.7	20.66	20.96	89	92	74	71	0.83	0.77	4.90	4.70	94	102	70	72
Oo Xing Joe	1.55	48.8	49.2	20.31	20.48	91	92	76	72	0.84	0.78	4.70	4.60	104	112	72	76
Kam Min Yi	1.66	50.7	50.8	18.40	18.44	93	91.5	71	69	0.76	0.75	4.40	4.80	97	91	65	63
Mean	1.57	48.85	48.91	19.82	19.84	90.65	91.33	70.67	69.15	0.78	0.76	5.07	4.94	98.81	101.42	66.77	68.27
Standard deviation	0.05	7.59	7.81	3.25	3.31	6.08	6.32	7.40	7.31	0.05	0.04	0.39	0.34	7.63	8.83	6.15	6.09

Appendix F (continuous)

Raw data of bowel function of 26 participants before and after the intervention

Name	Discomfort/pain		Loose,mushy or watery bowel motions		Diarrhea		Hard bowel motions		Straining		Urgency		Defecation		Number defecation	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Elisa Bong Tsyr Yin	0	3	0	0	0	0	0	0	0	0	0	0	14	14	14	14
Chen Yu Wei	1	1	1	0	0	0	2	1	2	1	0	2	6	11	8	15
Aw Xin Yin	2	2	1	0	0	0	2	0	2	0	0	1	10	9	11	10
Ngan Tung En	0	2	0	1	0	0	0	0	4	0	0	2	6	9	6	10
Chin Hui Xin	0	0	0	0	0	0	0	0	0	0	1	1	4	9	4	9
Fong Gui Ying	0	7	0	0	0	0	0	0	1	2	2	3	3	6	3	7
Kiat Qiao Ru	0	0	0	0	0	1	2	2	1	0	2	1	7	11	7	11
Ong May Qian	2	5	1	5	1	5	2	2	5	0	0	1	9	14	9	19
Foo Sze Ting	4	2	0	0	0	1	5	2	1	0	1	1	8	8	8	8
Siew Fei Kie	2	3	1	1	1	1	2	1	2	2	1	7	10	11	10	11
Wong En Li	0	1	2	4	2	2	0	0	0	0	2	2	12	13	18	18
Eunice Ng Yan Ling	0	0	0	0	0	0	0	0	0	0	0	0	5	14	5	14
Esther Lau Sin Wee	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	14
Chua Xue Lin	2	2	0	0	0	0	0	1	0	0	0	1	10	10	13	12
Yap Mei Teng	1	2	1	2	1	0	0	0	0	0	1	4	14	14	14	19
Wong Siew Ching	0	0	0	0	0	0	0	0	0	2	3	0	14	14	14	26
Cheah Xing Ling	2	2	0	0	0	0	0	0	0	0	0	0	8	10	8	10
Lai Pei Leng Echell	3	6	0	0	0	1	4	2	3	4	2	4	4	6	4	6
Ong Xuan	0	2	0	0	0	0	2	1	2	2	0	0	13	14	16	16
Lock Yee Sin	1	3	2	0	0	0	2	2	2	2	0	0	8	10	9	10
Soon Hui Yi	3	0	0	0	0	0	1	0	1	0	0	0	4	5	4	5
Lui Xin Yun	4	0	0	0	0	0	2	2	2	1	0	3	6	6	6	6
Cheryl Ng Ern Xin	3	2	1	4	2	3	2	1	0	0	0	0	14	12	14	12
Yap Yee Von	1	2	7	2	0	0	2	0	0	1	1	1	12	11	12	13
Oo Xing Joe	2	4	2	5	2	0	0	3	0	3	1	10	14	14	14	14
Kam Min Yi	0	1	0	3	0	2	0	0	0	0	3	2	4	7	6	10
Mean	1.27	2.00	0.73	1.04	0.35	0.62	1.15	0.77	1.08	0.77	0.77	1.77	8.96	10.62	9.65	12.27
Standard deviation	1.32	1.84	1.43	1.68	0.68	1.18	1.35	0.93	1.36	1.12	0.97	2.33	3.79	2.94	4.21	4.65

Appendix G

Turnitin Originality Report

Processed on: 10-Oct-2023 18:28 +08
ID: 2191275934
Word Count: 15984
Submitted: 1

FYP finalized By Hong Yi Quah

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Nazanin N. Abbasi, Peter P. Purslow, Susan M. Tosh, Marica Bakovic. "Oat β-glucan depresses SGLT1- and GLUT2-mediated glucose transport in intestinal epithelial cells (IEC-6)", Nutrition Research, 2016

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FACULTY OF SCIENCE

Full Name(s) of Candidate(s)	QUAH HONG YI
ID Number(s)	20ADB05582
Programme / Course	BSc (Hnours) Ditetics
Title of Final Year Project	INTERVENTION PILOT STUDY: EFFECTS OF BREAKFAST OATMEAL CONSUMPTION ON BOWEL FUNCTION AND HEALTH PARAMETERS AMONG UTAR KAMPAR FEMALE UNIVERSITY STUDENTS

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Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor
Name: Dr. Tan Gim Cheong
Date: 15/09/2023

Signature of Co-Supervisor
Name: _____
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