The Use of Nudge as Strategy to

Promote Healthy Eating

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The Use of Nudge as Strategy to

Promote Healthy Eating

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Declaration

I hereby certify that the material, which I now submit for assessment on the programme of study leading to the award of M.Sc., is entirely my own work and has not been taken from the work of others save to the extent that such work has been cited and acknowledged within the text of my own work. No portion of work contained in this thesis has been submitted in support of an application for another degree or qualification to this or any other institution.

Signed:  Date: 24/04/2022

Jussara Felden

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Abstract

Background: Design choice environments through nudge has been recommended in the food industry as a strategy for promoting healthier food choices, particularly among young adults for whom the eating habits are still flexible in comparison to mature adults. The present study involved a field intervention that aims to assess if the use of nudges strategies can increase sales of healthier food.

Methods: The study was divided into three independent phases: pre-intervention, intervention, and post-intervention, with the independent variable being the use of nudge strategies during the intervention phase and the dependent variable being the selection/purchase of the target food.

Results: We conducted a series of analysis of variance to determine whether the number of target foods increased as a result of the nudging interventions. In total we run eleven One way ANOVA, one for each target food (fresh fruit piece, fruit salad, porridge, soup, wholemeal bread, white bread, popcorn, crisps, mixed nuts, salad bowl and chocolate bar). The analyse of variance revealed that only the wholemeal bread ($p = 0.008$) and the white bread ($p = 0.028$) had statically significance. The wholemeal bread increased sales during intervention and the white bread reduced the sales during the intervention and post intervention phase. The other targeted foods presented an increase in sales, however the value of p was > 0.05.

Conclusions: In the present study we found out overall slight effects that are varied, fluctuating from strong to even unhealthy food choices. We conclude that, besides the heterogenic results, nudges can promote and improve the sales of healthier food in the university restaurant setting. However, there is a need for further studies to understand better how nudge strategies work with different food choices.

List of Abbreviations

ANOVA	Analise of Variance
B.M.I.	Body Mass Index
EPOS	Electronic Point of Sales
FAO	Food and Agriculture Organization
FSAI	Food Safety Authority of Ireland
Kcal	Kilocalories
Kg	Kilogram
Gr	Grams
HSD	Honestly Significant Difference
NCDs	Noncommunicable Diseases
RSPH	Royal Society for Public Health
WHO	World Health Organization

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Chapter 1

Introduction

INTRODUCTION

A healthy eating behaviour plays an important role for reducing risk of obesity and chronic disease (GBD 2017 Causes of Death Collaborators, 2018). Eating healthy can be very challenging, especially for young adulthood, as the food choice decision can be affected by financial and social transactions (Chopik *et al.*, 2018). In the young adulthood food choices are significantly affected by life transition as they normally have an unhealthy eating habits (Powell *et al*., 2019) with irregular meals, low fruit and vegetable intake and increasing consumption of unhealthy snacks (Sogari *et al*., 2018,).

In the food industry, design choice environments through nudges has been proposed as a strategy for promoting healthier food choices, particularly among young adults for whom the eating habits are still adaptable in comparison to mature adults' (Cesareo *et al*., 2022).

Since Richard Thaler's Nobel Prize in Economics, nudge has been noticeable in the interest of policymakers and researchers. Nudge is defined as "any aspect of the choice architecture that modifies people's behaviour predictably without precluding any options or materially altering their economic incentives" (Thaler & Sunstein, 2008).

In recent years, research has become increasingly interested in the characteristics of the physical environment, and so it has been found that, for example, portions and the size of food packages contribute to suggesting what and how much to eat, the simple proximity to food, or, again, the traffic light labels that indicate the healthiness of the product. Recent research has highlighted the role played by the type and order of presentation of foods, which, combined, have a great influence on food choices in terms of both quality and quantity (Bergeron *et al*., 2019).

In order to change food choices in people, nutrition interventions in nudge theory highlighted the role of nudge strategies. Field interventions are also needed which, thanks to simple and inexpensive nudging strategies (i.e. through simple changes to the surrounding environment, to push in a 'gentle' way - thus leaving freedom of choice - the

behaviour of people in the desired direction), individuals to eat better and less (Ensaff, 2021).

A balanced and healthy diet plays an important role in students' lives. However, eating healthy can be very challenging, especially for students. Sogari *et al*. (2019) demonstrated that unhealthy eating habits among young adults increase when they leave their homes. They typically consume fewer healthy foods, such as fruits and vegetables, have irregular meals, and consume an increasing amount of unhealthy snacks and "junk food," such as takeaways. Food choices have a significant impact on a student's life transition.

The use of nudging interventions has increasingly attracted interest from several researchers and studies as Bevet *et al.* (2018) demonstrated, they increased target food choice by utilizing the primacy effect and relocating the healthier item to the beginning of the service area. Cesareo *et al*. (2021) also demonstrates that nudging interventions are appropriate for university restaurants due to their advantaged setting for detecting variances in specific food choices.

Based on this context it is very important to have a deep knowledge and understanding of the effects on food choices in the young adults group to promote and improve healthy eating habits.

The present study will be beneficial for all customers of the Trispace Restaurant, as it is easy to apply, not invasive and literature review has shown the effectiveness of nudges to promote healthy food consumption. This research could also be beneficial to other colleges that aim to improve healthy eating among the students and staff users of their restaurants.

1.1 Research Question

The nudges strategy planned to use in this study will provide the data needed to answer the research question:

Can nudge strategies increase sales of healthier food items?

1.2 Aims and Objectives

The present study aims to assess if the use of the nudge strategies can increase customers' healthier food choices.

Objectives of the proposed thesis research:

1. To find out which nudge strategy work the best in the present study.

2. To find out if the nudge strategies are an efficient intervention to be transferable to other Trispace restaurants/ cafes.

1.3 Scope and Limitations

The present study involved a field intervention at Dublin City University's Trispace Main Restaurant. The study was divided into three independent phases: pre-intervention, intervention, and post-intervention, with the independent variable being the use of nudge strategies during the intervention phase and the dependent variable being the selection/purchase of the target food.

Product sales data was collected at 3 different times in order to answer whether or not the intervention was significant for sales in that period. Data was collected for two weeks, divided between the pre-intervention, intervention and post-intervention phase.

During the study we identify a few limitations. The study's first limitation was that we did not have access to the daily sales report. Due to a technical issue, the EPOS system did not run the daily sales per unit, which led our study to have fewer observational periods than planned and limitations in the statistical analyses. Another additional limitation was the time of the year the study took place, during the post intervention we

had March graduations which led to a less busy week than normal and may have restricted the possibilities to effectively assess the overall impact between the intervention phase and the post intervention phase. We also want to mention the lack of availability of the target food product, we ran out of fruit salad during 1.5 days of the intervention period due to the supplier's shortness of fruit salad.

The last limitation which may have affected our study was the COVID 19 pandemic. During the COVID 19 pandemic the restaurant was operating with disposable food containers only which was a barrier for the present study as food such as vegetables (side dish) could not be targeted due to the lack of ability to identify the target food at the checkout and register the target food accordingly at the EPOS system.

1.4 Thesis Outline

To answer the research question, Chapter 1 will go over the definition of a healthy diet, the importance of understanding food choices, and the definition, strategies, and classification of different types of nudge interventions. It will also give an overview of the effectiveness of the nudges that are used to promote people to eat a healthy diet.

Chapter 2 will outline the methodology used to answer the present research question. It will also describe the target population and all the four phases that the present study involved; preparation phase, pre-intervention, intervention phase, and post-intervention phase.

While Chapter 3 will present the results and findings and critically discuss the findings drawing validated expectations on the validity of the research question proposed in the present study. Finally, Chapter 4 will conclude the study and also present some limitations and recommendations for future work.

1.5 Definitions of Healthy Diet

A healthy diet is one in which macronutrients and micronutrients are consumed in sufficient quantities to meet energetic and physiologic requirements without exceeding the recommended daily allowance, while also providing adequate hydration to meet the body's physiologic requirements (Stark, 2013).

A healthy diet should be well balanced in order to guarantee the body the right supply of nutrients, thus satisfying the daily needs. What is particularly important, however, is the fact that it is now universally recognized by science and medicine that many diseases can be prevented through a correct, healthy and balanced diet (Lin & Ashcroft, 2017).

Franzo *et al.* (2020) defines healthy diet as a diet that is balance in quantity and quality of food intake and promote health. Additionally, a healthy diet should be economically and socially sustainable.

FAO/WHO (2019) established a broader vision of a healthy diet encompassing all aspects of sustainability. “Sustainable Healthy Diets are dietary patterns that promote all dimensions of individuals’ health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable”.

Cena & Calder (2020) explained that healthy diets around the world usually follow the WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases (NCDs) recommendations and also seeming moreover by tradition or design, part several mutual structures. The Mediterranean diet in comparison with Western diet, are healthier and based in a diet rich in vegetables, whole grains, legumes, nuts, fruits, seeds and plant-based food and they are designed to reduce the risk of diseases. However the authors emphasized that efforts are necessary to incorporate these healthy diets patterns into the daily life, and also underlined the need to make healthy eating accessible, achievable, and sustainable

Water food is not to be neglected because water is an indispensable and essential component of the Mediterranean diet, to the point of being at the base of the most recent

nutritional pyramids. However, in the diet, it is not enough just to choose the "right" foods. It is also necessary to know how to divide them equally on the plate: that is, in the right percentages, dedicating half the space to fruit and vegetables, a quarter to whole grains and a quarter to healthy proteins. But without neglecting the "good" quantities of food: never excessive and strategically distributed throughout the day with a rich breakfast, a frugal lunch and a light dinner (Michie & Johnston, 2012).

In summary, the definition of a healthy diet is constantly evolving to represent our growing understanding of the roles of essential nutrients, various foods, and other food components that impact in health and disease (Cena & Calder, 2020).

1.5.1 Diet and Health

Heart diseases and obesity have become the major public health problem in many countries worldwide, with major financial repercussions. The World Health Organization (2021) has estimated that, since 1975, the rates of obesity worldwide have tripled, with over 650 million obese people and 1.9 billion overweight adults. In other words, more people than the population of the European Union are considered obese, and nearly a third of the world's population is overweight. Faced with an emergency of this calibre, it is therefore clear that educating and raising people's awareness is not enough (WHO, 2021).

The importance of a healthy diet for reducing the risk of obesity and chronic disease is well known. The dietary choice is related to a variety of health problems counting obesity, cardiovascular disease, diabetes, some cancers (WHO, 2018; Koene *et al*., 2016) and, mental illness, arthritis, musculoskeletal disorders (WHO, 2018).

We can understand how a healthy and balanced diet can be essential for living well, and we can borrow a phrase from a famous world-renowned doctor. "None of us would dream of putting sand in the tank of our car, but in fact, we all do it with our body". It is not difficult to understand the comparison when we think about the harmful foods that we can introduce into our bodies. A healthy diet should be well balanced in order to guarantee

the body the right supply of nutrients, thus satisfying the daily needs. What is particularly important, however, is the fact that it is now universally recognized by science and medicine that many diseases can be prevented through a correct, healthy and balanced diet (Lin *et al*., 2017).

In recent years, epidemiological research has observed the associations between nutrition and mental health have expanded substantial importance (Firth *et al*.,2020). Lassale *et al.* (2019) in a systematic review has detected that individuals that follow the Mediterranean diet or healthy patterns, such as low ingestion of red meat, high ingestion of vegetables, fruits, nuts, and legumes; moderate ingestion of protein food such as poultry, dairy is linked with a reduced risk of depression.

Nevertheless, the cause of these relations is complex in Figure 1.1 show detailed the links between diet, physical and mental health.

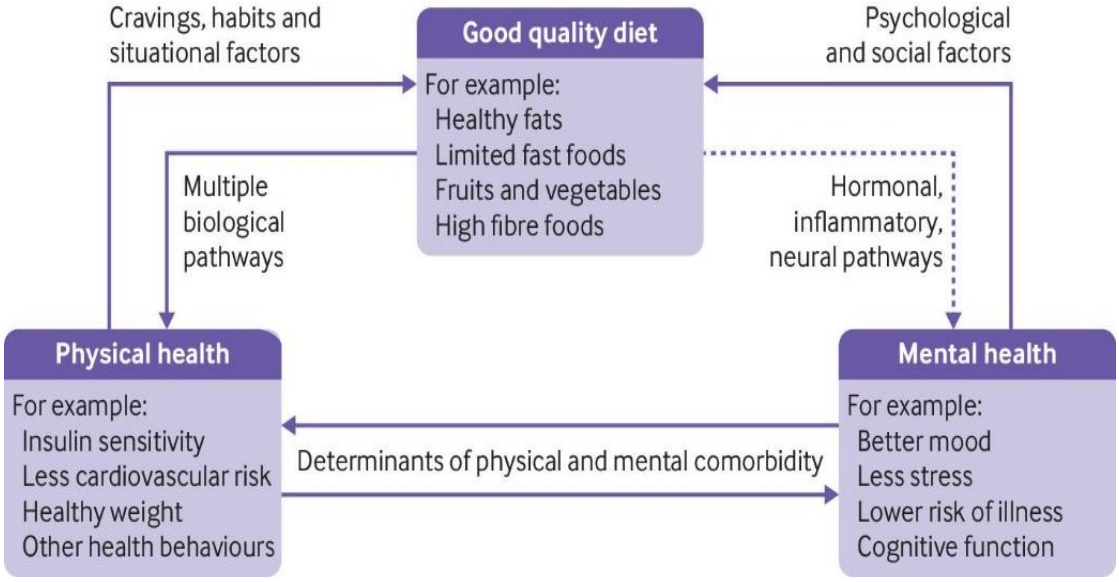

Figure 1.1 Relationship between diet, physical health and mental health (taken from Firth *et al*.,2020)

Therefore, there has been increasing concern about health promotion in the last decades, especially in the workplace (Sogari *et al*., 2018). Obesity is a prevalent pathological disease in humans that has existed since ancient times, persisting and worsening for ages due to genetic and environmental causes until it has now become a pandemic with terrible health implications (Bray *et al*., 2017). This increase in the prevalence of epidemic proportions is related to dietary factors and an increase in a sedentary lifestyle.

Increased diet of saturated fats and carbs, decreased intake of fruits, vegetables, and fish, as well as physical activity, which ranges from a lack of planned exercise to an increase in time spent doing activities with a significant sedentary base. This basis includes activities such as watching television or working on the computer, which are the most important causes of this global health problem (Williams *et al*., 2015).

Health promotion related to a proper diet is increasing in the workplace, especially in regions where obesity and chronic diseases are increasing. Epidemiological research on food and health has shifted its emphasis in recent years, from focusing on a specific nutrient, such as dietary fat, to focusing on the overall quality of the diet and the dietary pattern/choices. Improving one's lifestyle has long been seen as a crucial technique for reducing the risk of obesity. Furthermore, nutrition, one of the most important aspects of one's lifestyle, is critical. Obesity has been linked to various dietary factors, including calories, food types, and minerals (Asghari *et al*., 2012).

According to Wirt and Collins (2009), Diet quality is a word used to describe the overall nutritional quality and variety of identity. Therefore, it's crucial to understand the link between food quality and the prevalence of overweight or obesity to develop methods for preventing weight gain and improving population health (Aljadani *et al*., 2016).

Very recent studies in the Community of Madrid highlight that the weight overload figures in 2019 are 27.23% between 7 and 16 years old if the nutritional condition is evaluated from the body mass index (B.M.I.). However, considering other indicators such as the waist-to-height ratio, it is noted that abdominal obesity reaches 35.17%, an important issue since excess central fat is the one most closely related to the appearance of the components of the metabolic syndrome (Pasero *et al*., 2019).

The causes that have led to the current situation are varied. The excessive consumption of processed foods with a high energy value, rich in fat and sugar, and a sedentary lifestyle linked to urbanization processes and the change in transport models, are undoubtedly responsible. However, it is worth asking if the rapid socio-cultural changes have not allowed an adequate readaptation in those populations with a greater genetic predisposition to obesity. Furthermore, the role of diet during childhood and adolescence is also essential for total and visceral obesity and in developing childhood hypertension or other metabolic disorders at an early age (van der Valk *et al*., 2019).

1.6 Understanding Food Choices

Knowledge of food choice is essential to develop and implement successful health promotion efforts to deal with the prominent causes of morbidity and mortality. Even though various factors affect the development of morbidity and mortality, everyday choices, such as food choices, can also significantly impact health deterioration over time. Furthermore, everyday choices represent a vital chance to improve people's health (Powell *et al*., 2019).

Zorbas *et al.* (2018) stated that the most frequently reported influences on food choices in young adults are the convenience of unhealthy foods, a preference for the taste, and lack of time. Additionally, Willett *et al*. (2019) revealed that the new trends for healthy and sustainable diets promote the influence of food choices among young adults.

Afshin *et al*. (2014) reported that increasing data clarifies that complex and multiple factors ahead of personal decisions greatly affect dietary options and patterns. Therefore, the government may reflect these impacts as barriers, effect modifiers of food policies, and potential targets; see Figure 1.2 for detail of multidimensional influences that may affect food choices.

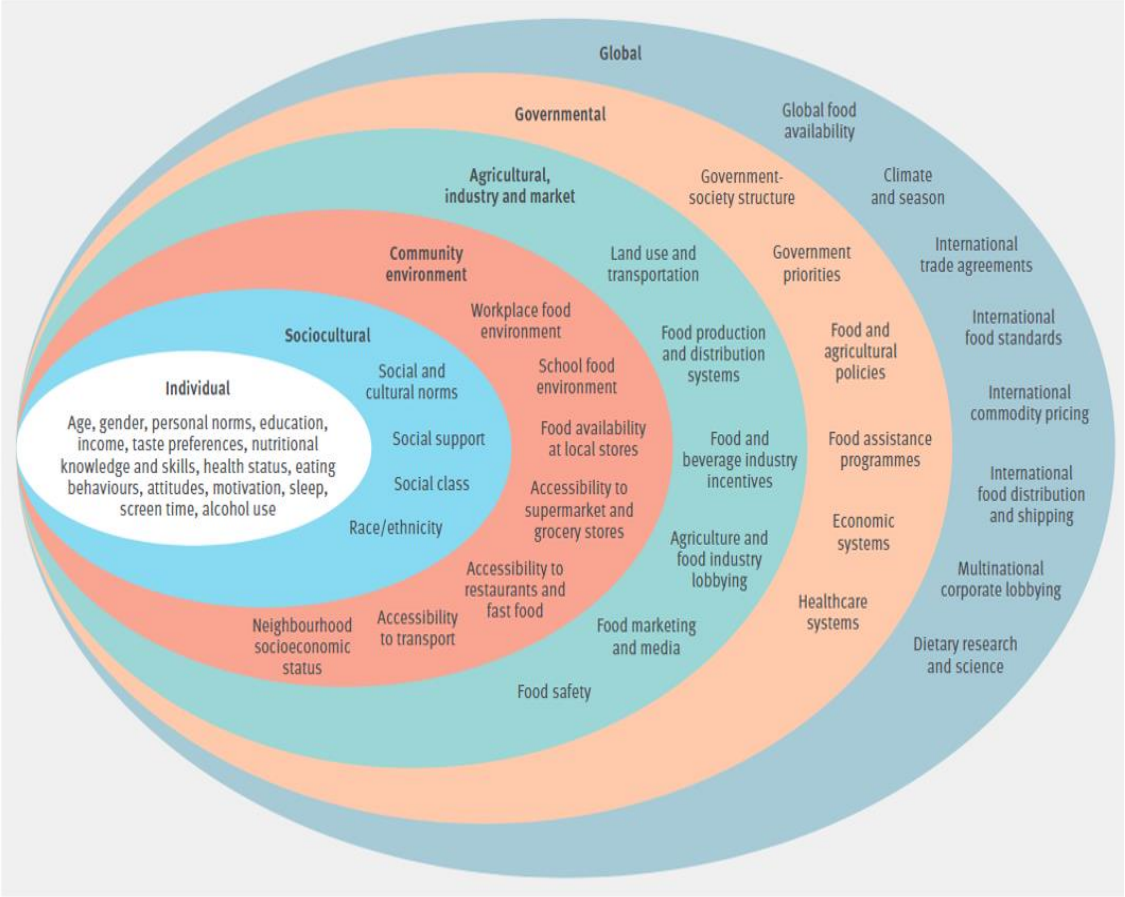

Figure 1.2 Multi-layered influences beyond personal knowledge and preference alter food choices (Taken from Mozaffarian *et al*.,2018).

Van't Riet *et al*. (2011) noted that psychological factors may impact an individual's food choices. Eating behaviours vary according to the mental state of an individual. In the brain, one has a reward system in which each experience is linked to an emotion, to a pleasant or unpleasant sensation. If someone is forced to eat a dish, this food will be associated with a negative impression (This is how certain dishes remain our obsession all our lives). On the contrary, if one feels pleasure in tasting food or that one is in good company to eat it, it will be linked to a positive experience. Sweet food, for example, gives us pleasure and pleasant emotions most often.

According to Nehring *et al.* (2015), early life events such as the mother's nutrition during pregnancy, infant feeding procedures, and foods consumed during early infancy may also influence food preferences. Household lifestyle patterns such as television viewing and sleep, family and community norms, societal pressures, socioeconomic status, social networks, and race/ethnicity all have an effect on human choices. Additionally, the surrounding environment has a significant impact.

Some sociocultural factors play a significant role in food choices. The family plays an important role in food choices. It has been shown that the choice of teenagers was similar to that of their parents, who were influenced by their consumption; this is all the more true if the teenagers participate in the development of the races. The example set by parents, the availability of food in the home, exposure to food diversification, the composition of meals, and meals eaten as a family contribute to the consumption of healthy foods, especially fruits and vegetables (Mozaffarian *et al*., 2011).

At the individual level, personal tastes, as well as gender, age, education, culture, education, money, nutritional and health status, and culinary knowledge and talents, all impact habits (Brug, 2008). According to Matek *et al*. (2020), few environmental and economic factors may impact the food choices. Food availability is an important factor in the choice of healthy food products.

Brug (2008), reported that the greater availability of fruits and vegetables, particularly within the home, would increase their consumption. Income, cost, and socio-professional category play a role in the food choices of any individual. However, the author highlighted that the most important factor is probably the cost of food. This cost generally leads to foods high in sugars and fats due to their energy content. Consequently, the greater the reduction, the more this type of food consumption increases.

1.7 Nudge Definition

The theory of nudge was defended by the economist, winner of the Nobel Prize in Economics, Richard H. Thaler and Harvard Law School Law Professor Cass R. Sunstein, explained in their book "Nudge: improving Decisions about Health, Wealth, and Happiness". Nudge is defined as "any aspect of the choice architecture that modifies people's behaviour predictably without precluding any options or materially altering their economic incentives" (Thaler & Sunstein, 2008).

We have seen how the decisions of human beings are strongly influenced by implicit thinking and the framing effect, how information is presented both at a macro level by the socio-cultural contexts of reference and by the presentation of stimuli, and how neuroscience highlight the complexity of the substrate of brain, cognitive and emotional, implicit and rational pathways. Scientific research allows us to evaluate how the human mind reacts to certain conditions and to identify the decision-making processes that activate choices (Thaler & Sunstein, 2008).

Knowing the principles of the functioning of the mind, it is possible to use strategies to create a context that favours the reaction of psychological involvement of engagement, or it is possible to encourage them to perform certain behaviours with "kind suggestions", both in the private context and in public (Cesareo *et al*., 2022).

Nudges, according to Thaler and Sunstein (2008), must strive to make the right decision well equipped, as evaluated by themselves. Means-paternalist nudges are preferable to ends-paternalist nudges. The ethically reprehensible replacement of ideals is avoided by means-paternalism: If nutrition nudges have been applied therefore if individuals worry regarding their health yet inevitably fail to promote it, they could be accused of forcing objectives on people. Develop a generative model that would end up making it much more probable that individuals would support their particular objectives, as they perceive them, nudges must attempt to do.

1.7.1 Nudge Strategies

Nutrition intervention strategies grounded in nudge theory emphasize the importance of nudge strategies in shifting food preferences. Clearly intentional choice architecture puts emphasis on the premise that the majority of food decisions are automatic, applying heuristics and biases as shortcuts, while nudge strategies help guide food selection toward desirable choices, encouraging or discouraging choice of target foods (Ensaff, 2021).

Psychological biases (e.g., present-based biases, choice display styles), as well as quick and unconscious impulses, strongly impact decision-making processes. Recent research has shown that strategies that target consumers' thoughts, rather than those that restrict their options, appear to have a higher influence on boosting the success of health promotions. These techniques are frequently associated with the term "nudge," which refers to the process of modifying people's behaviour without restricting their options. Because the environment in which individuals make choices can be altered and thus influence how decision-making processes that take place, nudging focuses on enabling and changing behaviour and decisions that benefit society (e.g., public health), rather than on delivering information or altering society's value system (Gonçalves *et al*., 2021).

Additionally, the nudging strategy involves priming in order to encourage people's behaviour over prompts; typically, this occurs subconsciously and includes trying to evade an individual's cognitive abilities (Blumenthal & Burroughs, 2012).

Acknowledgements to the studies of behavioural sciences, it is possible to employ strategic elements that favour certain cognitive and emotional pathways and encourage individuals to make voluntary choices and behaviours. conditioned by a gentle push as demonstrated by Thaler and Sunstein, in the book “Nudge, the gentle push”. Knowing the automatic reasoning errors, heuristics and cognitive distortions that characterize Humans, it is possible to create the conditions for developing the architecture of choices of individuals with the aim of suggesting and promoting the best possible choices (Thaler & Sunstein, 2008).

These stimuli that act as "goads", push to certain actions are simplifications of the decision-making process, such as varying the number and order of choice alternatives or selecting the default option. Learning to identify and mediate the automatic bio-psycho-social principles underlying decision making offers the opportunity to create the best context to favour certain choices at different levels. The modification of the environmental context has always been adopted to improve the output of marketing strategies, and now Nudging strategies are able to make the architecture of choices more efficient (Thaler & Sunstein, 2008).

Ensaff (2021), reviewed nudges strategies and assumed that understanding nudge strategies presents a compelling opportunity to reimagine the current food choice architecture. However, a clear methodology is required, and the relative lack of instruction on the application of nudges for experts has been highlighted. This process is mostly about two interdependent components: the nudge strategies themselves and the targeted food items (promoted/reduced), both of which should be taken into account concurrently.

The author also stated that analysing the specific choice architecture is critical to the nudge strategies work effectively. This is demonstrated in contrasting settings (hospital cafeteria, workplace cafeteria, a table service restaurant). Including in evidently similar situations, the unique structure of food selection must be thoroughly studied in order to achieve the desired effectiveness (Ensaff, 2021)

Ensaff, (2021) recognizes the critical nature of scientific foundations when working with behaviour change interventions, and robust theory provides a solid foundation for informing our knowledge of how and why nudge techniques may operate, as well as driving future developments in intervention strategy and effectiveness.

1.7.2 Classifying Nudge Strategies

The critical role of typologies and frameworks in advancing development in this field has indeed been recognized, especially in terms of facilitating empirical research and influencing practice and policy. This is a dynamic area, and there are parallels and distinctions among the numerous contributions.

As per the study conducted by Cadario and Chandon (2020), the main focus of the nudge strategy should be on changing people's behaviour. In this study, the authors analysed 96 articles that confirmed numerous methods for educating about food choices and eating behaviour. Seven distinct types of nudges for healthy eating were identified. These were further grouped into three types: behaviourally oriented, effectively oriented, and cognitively oriented; for a detailed description of the categorization, see Table 1.1.

Table 1.1 Seven distinct types of nudges, divided into three broad categories (based on Cadario and Chandon, 2020)

Categories	**Types of Nudges**	**How they work**
Cognitive nudges focus on providing information like nutrient counts or create healthy choices more noticeable on the display or menu..	1) Nutritional labelling that is descriptive	On the packaging, there is nutritional facts and a calorie content.
	2) Nutrient labelling that is evaluative	Images or graphics to back up your best options.
	3) Visibility enhancements	Placement of healthy foods should be changed.

Affective nudges attempt to motivate how individuals feel without essentially modifying what they understand, such as by emphasizing the taste of food rather than its wholesomeness.	4) Hedonic enhancements	Make healthy options appear more appealing.
	5) Healthy eating calls	Using decals or signage to help people make better decisions.
Behavioural nudges attempt to change people's behaviours without essentially modifying what they consider or want, such as altering the quantity of food on the plate or attempting to make healthier options simpler to choose and ingest.	6) Convenience enhancements	Convenient options of food to take away .
	7) Size enhancements	Change the servings of foods so that there are more healthy foods and fewer unhealthy food.

The authors stressed that the study's value lies not only in its ability to categorize interventions and assess their effectiveness, but also in its robustness when trying to control for population and study characteristics (Cadario and Chandon 2020),.

Michie S & Johnston M (2012) described numerous nudge strategies as assignment manipulation as revealed below:

• The placement of food alternatives (e.g., adjacent the check-out, nearer to the consumer, at eye level);

• The use of semiotics (images or signs, like healthy heart labels, emoticon decals).

• Modifications to the arrangement/size of food (e.g., plate size, serving tongs, grab-and go pots);

• The order of food substitutions (for example, first option on a menu, first in a buffet/canteen line);

• The accessibility of food alternatives, for example, the number of promoted items available;

• The addition of descriptive names for target foods, such as the menu description, slow-roasted sweet potato, or prompts, either written or verbal, such as 'Would you like a side with that?' or 'Make a fresh choice';

• Defaults (i.e. default choices that persist unless an individual intervenes) can be used in nudge strategies, such as shifting the default meal choice to a plant-based option.

As Thaler & Sunstein (2008) recognize, nudge strategies maintain the freedom of choice by not removing food options and by not shifting economic incentives; however, they may also include changes to the arrangement of food options, accessibility, availability, and the use of prompts. Figure 1.3 illustrates nudge strategies related to food (taken from H. Ensaff, 2021).

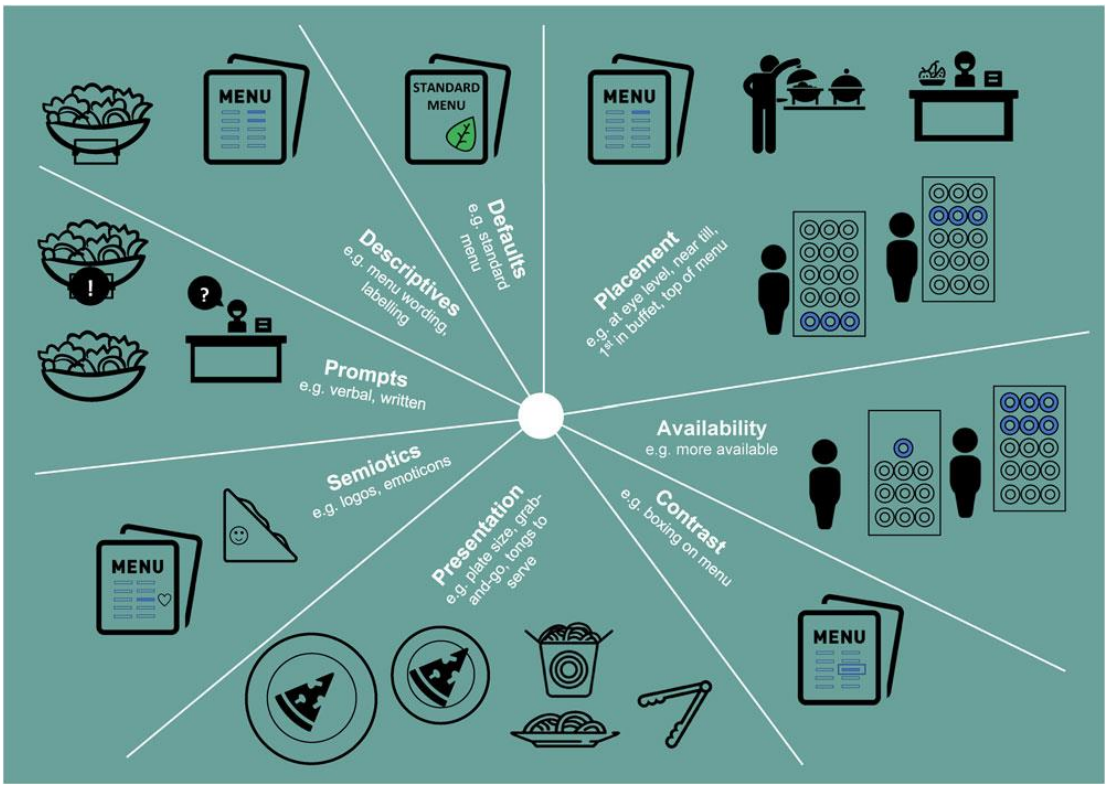

Figure 1.3 Nudge strategies used in choice architecture intervention studies to influence food selection (taken from H. Ensaff, 2021).

In a systematic review done by Cesareo *et al.* (2022), diverse nudging strategies used in the literature review where records were grouped agreeing to the classification provided by Sunstein, (2016):

- Increasing (or decreasing) ease/convenience;
- Attracting or reducing attention;
- Establishing default rules;
- Providing disclosures;
- Priming strategies;
- Ordering effects;

It is necessary to gain a working knowledge of how and why nudge strategies might work. A detailed description of the food choice can be obtained by mapping and photographing

the food environment, as well as by conducting observation visits and conducting interviews (Ensaff, 2021).

1.7.3 Implementation of Nudges Strategies

Nudges strategies are being implemented in many different fields and context. International research, including in the United Kingdom and Europe, is being performed, with the majority of evidence coming from US research. Several of the studies were conducted in laboratories (Hunter *et al.*, 2019, Knowles *et al*., 2019). Others in online environments (Blom *et al*., 2021). Furthermore, an increasing body of research is being conducted in proper food settings, including university restaurants (Bender *et al*., 2016, Bevet *et al*., 2018, Cesareo *et al*., 2022, Cioffi *et al*., 2015, Sogari *et al.*, 2018), supermarkets and retailers (Gonçalves *et al.*, 2021, Trafford. and de la Hunty, 2021), workplaces (Montagni *et al*,. 2020, Marcano *et al*., 2020).

One example of the different context that nudges are being implemented is the project between the Royal Society for Public Health (RSPH) and the Slimming World association which set itself the goal of designing a supermarket conceived by professional dieticians. The basic idea was to limit the visibility and space granted to "junk food", indeed placing healthy foods in pre-eminent positions, all accompanied by short demonstrations of healthy cooking and recipe books designed to promote a balanced diet. Junk food, although present in the store, is never arranged at the level of the eye: however, a healthier alternative is always placed next to it (RSPH & Slimming World, 2019).

1.8 Effectiveness of Healthy Eating Nudges

Numerous researchers are examining the effectiveness of various nudge experiments. Cadario and Chandon (2020) in a systematic review and meta-analysis examined ninety-six studies of choice architecture interventions in real-world settings. They used the

Cohen's d to organize the data and determine the effectiveness of each type of nudge (standard mean difference).They were able to relate the effectiveness of studies using distinct units of measurement after standardizing the mean differences.

The authors multiplied the standard deviation of an adult's daily energy intake by the Cohen's d value to gain a better understanding of nudge effectiveness. When the researchers examined the entire healthy food nudge intervention, the Cohen's d value was only 0.23, which was not statistically significant. But at the other side, when the experiment results were divided into behavioural, cognitive, and affective categories, it was discovered that certain nudge interventions are more effective than others. See Figure 1.4 with the effect side by each nudge type.

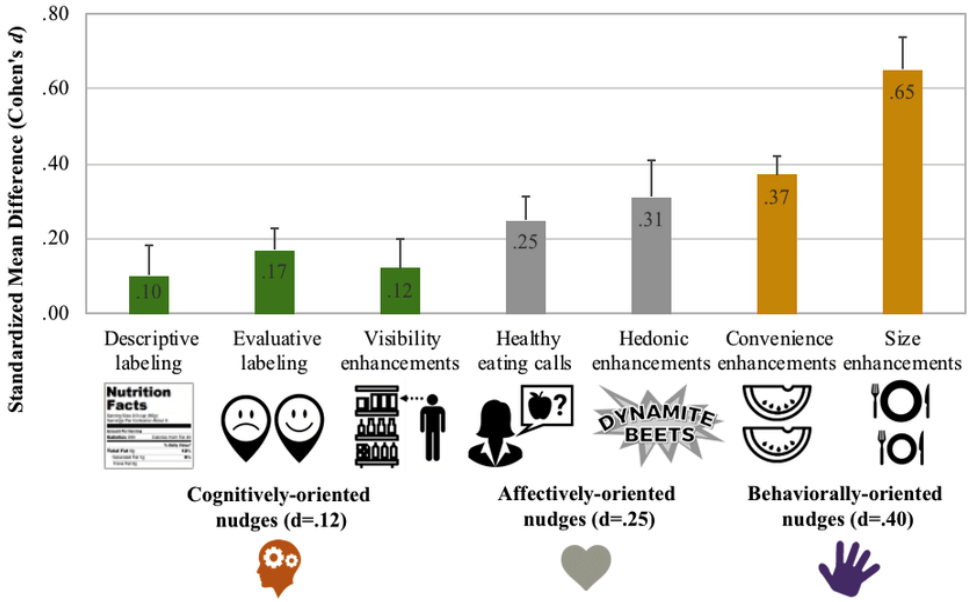

Figure 1.4 Effect Sizes by Nudge Type (taken from Cadario and Chandon, 2020)**.**

Although considered small, Cadario and Chandon (2020) translated this to an equivalent to124 kcal/d). Additionally, effect sizes increased as the nudge strategy's focus shifted from cognition to affect to behaviour, with the biggest effect size becoming the equivalent of 209 kcal/d.

They maintained that behavioural nudges were shown to be much more efficient than an individual's psychological nudges, having the capability to minimize daily caloric intake by roughly 320 kcal, according to the research. Affecting the amount or quantity of food offered or sold, according to the researchers, is especially successful since it does not need decision or participation. Emotional nudges that favourably promote healthy food alternatives decreased calorie intake by 129-162 calories, whereas intellectual nudges lowered caloric intake by 54-91 kcal based on the strategy (Cadario and Chandon, 2020).

Hansen *et al.* (2021) conducted three randomized trial field experiments, one of which used a vegetarian lunch as a standardisation indicator. Participants in the study were randomly assigned to one of two groups at each of the three conferences. Group 1: Participants were given the option of registering for lunch with a non-vegetarian buffet as the default option, but were allowed to select a vegetarian option. While group 2 participants were given the option of a vegetarian buffet as a default, they were also given the option of a non-vegetarian buffet.

The majority of participants (94 percent) accepted the vegetarian default option in all three experiments. The authors concluded that default options can be an effective nudge strategy for increasing sustainable and healthy food selection. Figure 1.5 illustrates the details of the three experiments. In experiment A, vegetarianism increased from 2% to 87.5% (N = 08, P 0.001). It increased from 6% to 86 percent in experiment B (N = 112, P 0.001). It increased from 12.5 to 89 percent in experiment C (N=110, P 0.001) (Hansen *et al*., 2021).

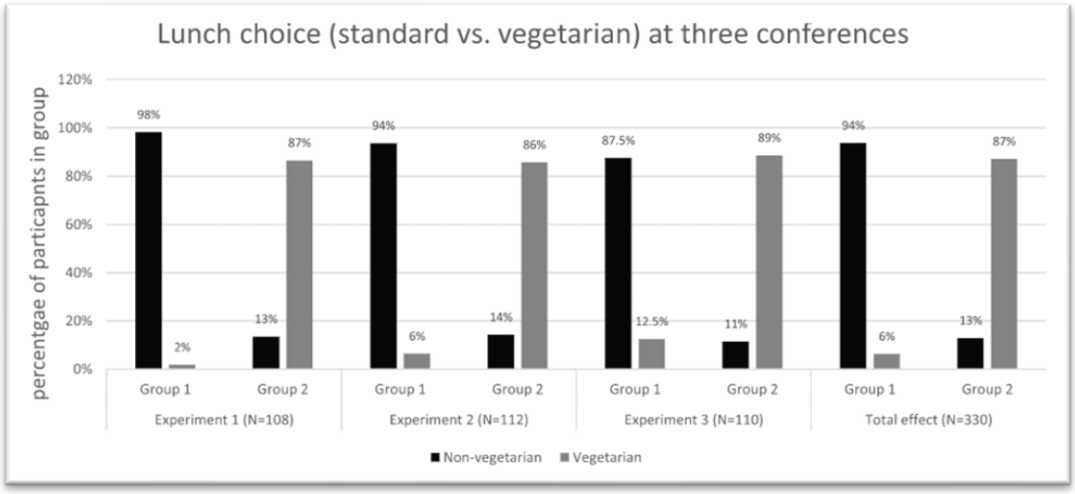

Figure 1.5 Lunch choice (standard versus vegetarian) at three conferences (taken from Hansen *et al*., 2021)

A systematic review and meta-analysis completed by Broers *et al*. (2017) to find out if the consumption of fruit and vegetables increased with nudging strategies. The results of the meta-analysis that involved 14 studies showed a moderately significant effect that nudging interventions had on food choice, particularly with the strongest effect on combined nudges and altering placement.

While Wright and Bragge (2018), reviewed 183 primary studies assessing support in 3 nudges intervention strategies: provision of health information, manipulation of size, and social models/ norms. They found out that only social norms intervention had a strong effect on food intake, while the effect of the provision of health information and manipulation of portions size and had a small-to-moderate effect this was revealed to reduce calorie consumption.

Hoenink *et al.* (2020) investigated the effects of nudging and price on healthy food purchase behaviour in a virtual supermarket setting and discovered mixed results. The most significant result was that merging nudges with prominent pricing methods increased the share of healthy purchases. These findings corroborate prior research

demonstrating that while price reductions and statement on your own did not increase sales of targeted goods, the joint strategy significantly increased sales of advertised products.

Budd *et al*. (2017) also reported similar findings. Joining pricing and nudging strategies may have a cumulative effect due to the fact that numerous intervention tactics target various levels of influence. It is important to mention that Thaler & Sunstein, (2008) clear mention that nudges strategies must not altering their economic incentives, so the price of the product should not be change in the nudges strategies.

Van Kleef *et al.* (2018) conducted a study to investigate the impact of whole wheat bread as the default option in a sandwich selection situation in a university stand. Wholemeal bread is made entirely of whole grains and is therefore healthier than other breads that are usually served, such as white bread. the results indicate that whenever the wholemeal bread was the default option, 94% of the participants ended up choosing it. When white bread was offered as the default option, 80% of the participants ended up choosing it. In all situations, individuals feel equally free to choose. According to the findings of this study, bread type has a strong default effect. The authors concluded that the results clearly shows the value of persuading customers to choose healthier bread by offering healthier default bread in a range of locations such as restaurants, schools, and workplace canteens.

1.8.1 The Effectiveness of a Proximity Nudge

Although studies indicate that removing food from people's reach reduces the likelihood of consumption. Nonetheless, little research has been conducted and established regarding how proximity affects consumption when both healthy and unhealthy foods are available (Hunter *et al*., 2018).

Kroese *et al*. (2016) conducted an naturalistic study in a kiosk in the train station with a control shop. In the study the authors measured the snack sales level increased or decreased by placement the healthy snack option near to the till area. They found out that

the healthy snacks closely to the checkout doubled the sales from 161 to 287, in the first week of the intervention. However when moving the position of the healthy snack had no significant impact on unhealthy snacks sales.

Hunter *et al.* (2018), agrees with this suggestion showing that by moving the item (M&M's) in a direction away from a person that it reduced the likelihood that the person will choose the snack.

A study shown by Van Gestel *et al*. (2020), "Beyond Discrete Choices – Investigating the Effectiveness of a Proximity Nudge with Multiple Alternative Options" explored the effectiveness of the proximity nudge with numerous options placed in near proximity of the targeted food option. Based on the theory that the more options are available to choose from results in the increase of the complexity of the choice.

In order to see the effective results of the proximity two studies were presented showing two partakers from the community sample chose a piece of chocolate from a variety of either three or nine alternatives with equal utility. 50% of the partakers repositioned the options by placing the target chocolate to be closer to the participant. The author of the study concentrated of the probability of choosing an item for consumption rather than the likelihood of intake or the amount of intake (Van Gestel *et al*., 2020).

Partakers firstly received the primary questionnaire that is used for research purposes. Then, the questionnaire partakers were compensated with a chocolate of their preference.

See figure 1.6 (taken from Van Gestel *et al*., 2020) to details of the experiment 2 on the table setting. The four squares represent the table, while the bold lines at the at the lowest part of the table represent the side where the partakers would approach to the experiment. The blue filled circles represent the dishes whit the target chocolate while the circles without fill would represent the bowls with chocolate.

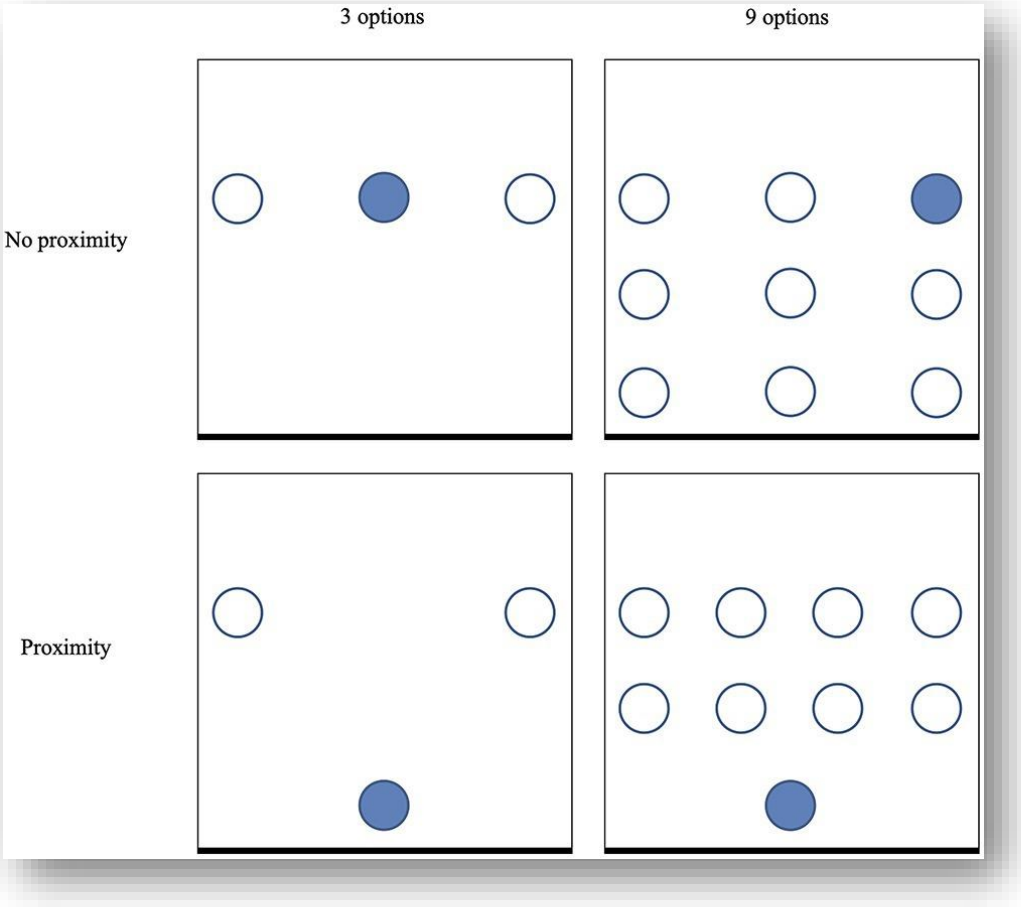

Figure 1.6 Schematic overview of the set-up in Study 1. (taken from Van Gestel *et al*., 2020).

The authors discovered that study 1 provided evidence of the effectiveness of the nudge theory on par with options three and nine. They furthermore discovered strong indication that the hypothesis is effective regardless of how many options are there to choose from.

The results in question suggested it was less complicated for partakers to choose chocolate from a limited selection, however, without substantial evidence they decided to run a study to look into it further. Study 2 is an improved version and larger sample.

See figure 1.7 (taken from Van Gestel *et al*., 2020) to details of the experiment 2 on the table setting. The four squares represent the table, while the bold lines at the at the lowest part of the table represent the side where the partakers would approach to the experiment. The blue filled circles represent the dishes whit the target chocolate while the circles without fill would represent the bowls with chocolate.

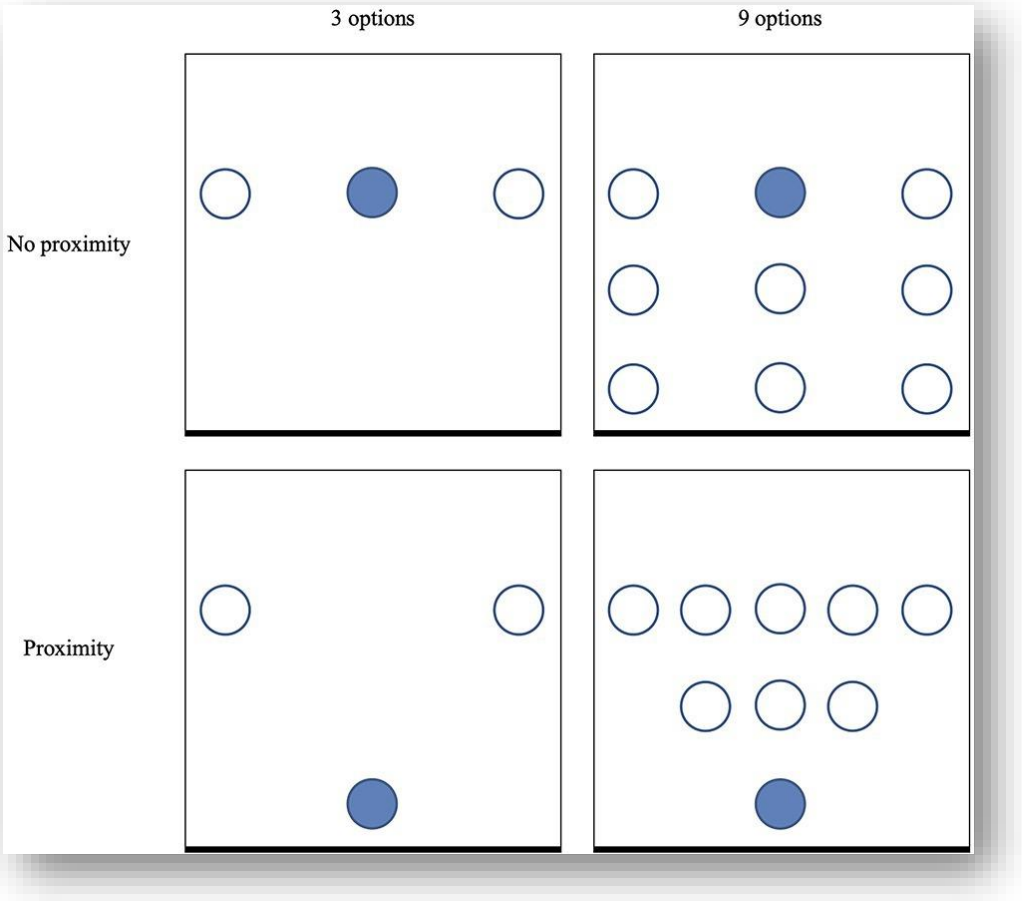

Figure 1.7 Schematic overview of the set-up in Study 2. (taken from Van Gestel *et al*., 2020).

When compared to study 1, study 2 demonstrated similar effects, indicating stronger evidence on the efficacy of the proximity nudge on the likelihood of occurrence of choosing the specific chocolate regardless of the options provided. Furthermore, follow-

up comparisons revealed that partakers were less assertive in their choices as a result of the nudge in the situation with three choices but didn't really find an equivalent tendency with nine options (Van Gestel *et al.,* 2020).

The two experiments with public samples revealed that the proximity nudge has an effect on food choice in both a particularly complex choice context with multiple options and a real-life simple choice establishing. Besides that, the findings of this study provided strong support for the efficacy of a proximity nudge, as individuals making the aim chocolate more than twice as likely when the dish was placed close to the participant (Van Gestel *et al*., 2020).

1.9 Limitation of the Effectiveness of Nudges

Eating nudges is a consumer behaviour where consumers make decisions based on mental or heuristics and biases that may lead to sub-optimal decisions. Health eating nudges have been studied a lot, but inadequate understanding about how, when, and for whom which type of nudges fail and work are still persistent. Due to this limited understanding, there are several limitations to the effectiveness of healthy eating nudges (Marchiori *et al.*, 2017).

First, Wilson *et al. (*2016) and Szasti *et al*. (2018) expressed concern about the ambiguity surrounding the effectiveness of nudging food choices, owing to the diversity of published studies, each with a unique setting, population, and methodology; as a result, the findings could not be standardized.

Second Bucher *et al.* (2016) added an extra significant limitation in evaluating the effectiveness of nudging, is that greatest numbers of studies do not account the size of the sample being investigated, limiting the likelihoods to effectively evaluate the total impact.

Thirdly, as cited by Marchiori *et al*. (2017), people might be oblivious of at least three components of an intervention in the case of nudging behaviours. The physical signal initiates the action, the unconscious process, and ends the behaviour. It is possible to consider disclosing the nudge itself, the automated process, and the resulting behaviour regarding nudging interventions (e.g., eat healthy food).

Finally, a piece of writing with a message is displayed on the front counter, and the message "we are assisting you in making healthier choices" may not be understood as intended. According to Junghans, Cheung, and De Ridder (2015), this indication had no effect on the efficacy of a repositioning nudge aimed at increasing healthier food choices. These findings indicate that the majority of people understand the value and benefits of a healthy diet and may even welcome and be prepared for such interventions. Although the findings appear encouraging, it is unknown whether consumers noticed the sign and, if they did, whether they believed it would influence their decisions. When the purpose of the nudge was revealed to customers in a follow-up interview, they were certain that the nudge had no effect on their food selections.

1.10 Nudges and Ethic

Nudge policies aim to enhance people's choices by altering how alternatives are given to individuals instead of just altering the alternatives directly or motivating or coercing people. Nudging has indeed been welcomed with a lot of optimism as well as a lot of criticism. Researchers can enhance people's choices by modifying how possibilities are conveyed to users instead of revising their options or market mechanisms. (Hausman and Welch, 2010)

In contradiction to certain other varieties of paternalism, libertarian paternalists value personal preferences. In Nudge, Thaler and Sunstein (2008) introduce the idea of nudges as a means of encouraging required decisions without interfering with freedom of choice, which they define as "libertarian paternalism." The basic understanding is that the person who creates a choice scenario introduces the choice in such a way that the target choice

is encouraged, with preferable referring to beneficial to the decision maker or to society as a whole.

The argument in favor of nudges is simple: they efficiently enhance health while restricting people's liberties. The nudge strategy, offers cost-effective measures that encourage positive policy results. Cognitive science discoveries provide governments with additional features to encourage improved health, behavioral intention, and tax collection, among several other things. Furthermore, nudges are quite inexpensive and simple to deploy. (Sunstein, C.R., 2015)

Transparency in the concept of nudging relates to the nudge becoming revealed to the policymaker. A "transparent" nudge, as opposed to a "non-transparent" nudge, has indeed been suggested to be more humane, particularly in favor of letting for independent decision-making. The logic being is that disclosing the nudge helps the responsible party to identify distinct decisions based on his own principles instead of being innocently influenced by it. Furthermore, this one has been questioned regardless of whether nudges will still be successful if they were made public (Harbers., 2020).

Clavien (2018), pointed that the fact that nudges were demonstrated to be useful and now are in practice, there is always a debate concerning of nudges ethics. The emphasis of this debate is already on the idea that nudges may have a negative influence on independence. A clear nudge has earlier been suggested as a proper alternative solution. Although previous studies have demonstrated that transparency does not affect the effectiveness of nudges, it's indeed uncertain if transparency seems to have an influence on freedom, decision satisfaction, or perceived pressure.

Some studies found that customers do not mind being nudged and that the effect of nudges does not change when the consumer is aware they are being nudged, but they also recommended additional research (Kroese *et al.,* 2016, Bruns *et al*., 2018). Junghans and Cheung, 2015 revealed that once there is a transparency and a relevant acceptability of the population being nudge it means a step forward for the implementation of nudges at government level.

Chapter 2

Methods and Materials

2. METHOD AND MATERIALS

This chapter will describe the methodology of the current study that involved a field intervention carried out at Trispace Main Restaurant at Dublin City University. We will describe the target population and all four phases that are involved in the study; preparation , pre-intervention, intervention and post intervention phases.

It will detail the nudge strategies used during the intervention phase and also list the target food items we have chosen for the current study.

Finally, we will describe the data analysis performed on the data collected. To determine whether nudge strategies increased or decreased the number of target foods sold, we compared the number of sold target foods during the pre-intervention phase to the number of sold target foods during the intervention and post-intervention phases.

2.1 Study Design

The present study consisted in there independent phases the pre-intervention, intervention and post intervention phase in which the independent variable was the use of nudge strategies during the intervention phase and the dependent variable was the selection/purchase of the individual target food.

2.2 Location and Population

The present study involved a field intervention at Dublin City University's Trispace Main Restaurant. The main restaurant is open from 7:30am to 4:00pm serving approximately 900 to 1000 meals daily. The restaurant caters mostly to university students, however staff, academic and visitors also purchase and consume food on the premisses. There was

no recruitment in this study. To collect the data it was generated weekly POS reports that included the quantity of purchases of the target foods necessary for the present study.

The study included four phases:

- Phase 1- Preparation
- Phase 2- Pre- Intervention
- Phase 3- Intervention
- Phase 4- Post Intervention

All the phases will be describe in sub-sections.

2.2.1 Preparation - Phase 1

This phase the researcher made sure all the buttons on the electronic point of sales (EPOS) system are specified correctly and working properly for the accuracy of the data collection for the present study. Each target food had a specific button on the EPOS system. See Table 2.1 for full list of target foods for the present study. It is important to mention that the target foods were available every day in the restaurant during the entire study.

Table 2.1 List of the targeted food at the present study.

Target Food	Food to be compared to
Wholemeal bread	White bread
Popcorn	Crisps
Mixed Nuts	Chocolate bars
Salad bowl	N/A
Fruit salad *(a)*	N/A
Piece of fruit *(b)*	N/A
Soup *(c)*	N/A
Porridge *(d)*	N/A

(a), (b), (c) and (d) For the fruit salad, piece of fruit, porridge and soup it was not possible to have a specific food to compare with each as there was a large variety of food offer available for customers to choose from.

The target foods were chosen based on the healthiest options available. The intervention targeted the group of fruits (fruit salad, piece of fresh fruit), vegetables (salad bowl and soup), cereals/bread (homemade porridge and wholemeal bread). It was also targeted the healthiest snack at the checkout area which is a small packet of mixed nuts (45gr) and it was compared with the available chocolate bars. Additionally at the checkout area it was targeted the popcorn (30gr) which was compared with crisps as they are displayed beside each other at the checkout area.

The piece of fresh fruit and fruit salad was chosen as healthy target food following the guideline of the Healthy Ireland Food Pyramid as a good source of nutrients, specially protective nutrients that protect against heart disease and cancer. They are also low in

calories and help control body weight. The fruit salad pot sold at the restaurant contains 50kcal per portion (165gr).

The present intervention target the salad box and the soup to be representative of the vegetable group. The salad box contains a variety of vegetables and salads providing a range of vitamins and minerals, they are generally low in calories and in fats (FSAI, 2019). The homemade soup is made from vegetables that provide a range of vitamins, it is our sustainable dish as it is made using sustainable in season vegetables purchased from local fruit and vegetable suppliers. It is important to mention that it was planned to target the vegetables as a side dish but due the Covid 19 pandemic the food in the DCU main restaurant has been served in takeaway containers which becomes a barrier in identifying the vegetable at the checkout area.

The wholemeal bread was target to compare with the white bread option. The both options of breads was offered in daily basis at restaurant. In this case we targeted the wholemeal bread as the healthier option based on the guideline of the Healthy Ireland Food Pyramid that recommend to choose fibre-rich carbohydrates such as wholemeal breads over white breads. Wholegrain breads contain all the nutrient-rich germ and the high-fibre bran (FSAI, 2019).

The popcorn was chosen as a healthier option at the checkout area and in compared the popcorn to the crisps. The target popcorn, (pack of 30gr) has 132 calories, 5.6 grams of fat, 19.8 grams of carbohydrate and 2.9 grams of protein while the crisps available are higher in fat and calories than the popcorn. A 45gr serving of regular crisps has 236 calories, 15.4 grams of fat, 20.7 grams of carbohydrates and 2.6 grams of protein, in addition the popcorn has 4.8gramas of fibre. Popcorn was reported more satiating than crisps in normal-weight adults (Nguyen *et al., 2012)*

Another target food at the checkout area was a packet of mixed nuts as our healthier options and we compared the sales against the chocolate bars that are available. The packet of nuts was chosen as the healthier option as the packet of nuts contains Brazil nuts which are booster rich in selenium and also recommended by a healthy snack by

guide supporting the Healthy Ireland Food Pyramid as a good source of heart-healthy monounsaturated and polyunsaturated fats and a good source of fibre (FSAI, 2019).

Table 2.2 List of the targeted food with the health benefit (based on FSAI, 2019)

Target Food	Health Benefits
Wholemeal Bread	Provides fibre and helps protect against constipation and bowel disease.
Mixed Nuts (Packet of)	Good source of heart-healthy monounsaturated and polyunsaturated fats and a good source of fibre.
Homemade Fresh Salad Bowl / Vegetable Soup	Vegetables and salads provide a range of vitamins and minerals, they are generally low in calories and in fats.
Fruit salad / Piece of Fresh Fruit	Rich in protective nutrients that help protect against heart disease and cancer. They are also low in calories and help control body weight.
Porridge	Low in calories, fat and salt. Has a special fibre called beta glucans that helps lower cholesterol and prevent blood sugar spikes.
Soup	Provides a range of vitamins, low in calories and is a sustainable option.

2.2.2 Pre- Intervention - Phase 2

In the pre-intervention phase, all targeted food were captured by the EPOS system for ten consecutive business days (two weeks). All targeted food were entered through a specific

button facilitating the accuracy of the data collection. In this phase, no interventions were done and the menus were displayed and food was served in the restaurant as usual.

2.2.3 Intervention - Phase 3

All targeted food were verified for ten more consecutive business days in the intervention phase. In this phase a range of nudging strategies were adopted to promote the selection of healthier choices (target foods). The restaurant was restructured during the first morning of the intervention phase before opening the restaurant. The researcher of the study managed the changes. It is important to mention that the researcher worked with the duty restaurant managers to ensure to keep the nudges strategies on place.

For the current study we follow the nudges strategies used from Sunstein, (2016). See below the nudging strategies that were applied during the intervention phase in the present study:

Providing disclosures: A labelling system such as "Good for you" were used to make more noticeable healthy options. The labels were placed beside all healthy targeted food option (fresh fruit piece, fruit salad, salad bowl, wholemeal bread, porridge, soup, mixed nuts and popcorn) . Also the "Good for you" icon was placed beside the healthiest options available on the menu at the restaurant's entrance. Finally, posters with clarifications about the purpose of the label "Good for you" were located at the restaurant entry near the menu wall. See Figure 2.1 A & B with the label and poster "Good for you" displayed at restaurant entrance.

Figure 2.1 A & B The icon (A) "Good for you" were designed and used to make more noticeable healthier options. The poster (B) with a brief explanation about the function of the label "Good for you".

It was also introduced a new label with nutritional information for the fruit salad. Providing disclosers as nutritional information was another intervention to promote the sales of healthy option, in this case the fuit salad. We used the software Nutritics, Insight premium V5.74 to calculate and generate the labels. See Figure 2.3 with changes in the fruit salad label before and during the intervention.

Figure 2.2 The image A shows the label of the fruit salad before the intervention and the image B show the label with nutritional information during the intervention.

Priming*:* It was displayed on a small poster beside to the porridge station and soup station to promote the target food option. See Figure 2.3 for details of the message that highlighted its health benefits, a poster was also located at the main entry near the menu to prompt the clients the health benefits of fruit, see Figure 2.4 for detailed messages.

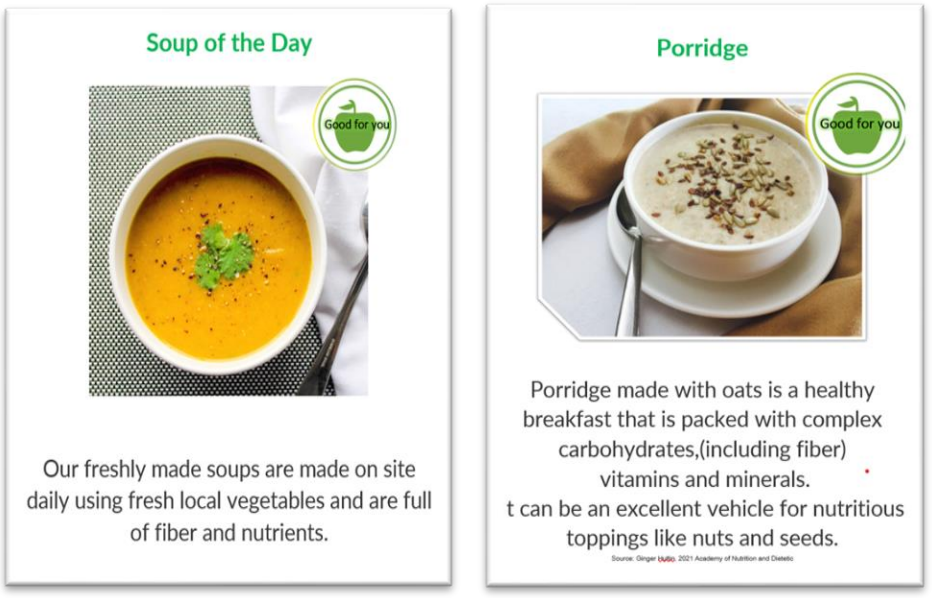

Figure 2.3 Posters displayed near the soup station and porridge station during the intervention phase.

Figure 2.4 Poster displayed at Restaurant main entrance during the intervention phase.

***Attracting or reducing attention**:* Targeted food as such fruit was made more visible by displaying in front of the counter and placing some display risers under the fruit bowls. Also the fresh fruit pieces were displayed at the eye level at the top of the counter.

Increasing ease/convenience: The wholemeal bread was placed closer to the soup station and displayed in front of the white bread to make the choice of the target food more prominent. We also displayed the wholemeal bread near the breakfast station to encourage customers to have it with breakfast rather than white toast. The popcorn was placed in front of the crisps to make the target choice easier to select.

2.2.4 Post Intervention – Phase 4

In the Post Intervention the nudges strategies were removed and the food was displayed as before the intervention. All the targeted food were captured by the EPOS system for ten consecutive business days (two weeks).

2.3 Data Analyses

For the analyses of the data collected the researcher used the Statistic software Minitab 19.2020.1.

In this work, statistical techniques were used to study the data. The first step was a descriptive analysis. The objective of this step of the data analysis process is to check for missing data or some other discrepancy in the data that could influence the subsequent results. It is important to empathize that the descriptive analyses were constrained by a technical issue with the EPOS system, as we could only obtain the quantity sold per week rather than per day it limited the study's ability to compare and conduct deeper analyses.

The sales of the target food was collected for three different phases of two week periods; the pre-intervention, the intervention and the post intervention in order to answer whether or not the intervention (nudges strategies) was significant for sales of the target food in each period.

To determine whether nudge strategies increased or decreased the number of sold target foods we compared the number of sold target foods during the pre-intervention phase to the number of sold target foods during the intervention and post-intervention phases.

To find out if the intervention worked for all the target food we conducted One Way ANOVA followed by the Tukey's Test. The Tukey test was conducted only if the p- value was less than the 0.05 significance level and it was possible to reject the null hypotheses and conclude that the factors have different means. We run the same analysis separately for each specific target food (fresh fruit piece, fruit salad, porridge, soup, wholemeal bread, white bread, popcorn, crisps, mixed nuts, salad bowl and chocolate). In total,11 ANOVA were executed, one for each target food.

One of the purposes of applying ANOVA is to perform the statistical test to verify if there is a difference between the units of target food sold and the distribution of the units among the pre intervention, during intervention and post intervention. If the groups present the same variability and the same performance average their distributions tend to overlap, confirming the hypothesis that there is no difference between sales performance, otherwise when the groups have the same internal variability and different performance means the distributions are farther apart and the more the performance means differ.

Among the most used multiple comparison tests, the Tukey Test stands out for being powerful in making comparisons between all pairs and also for being easy to apply. It is also known as the Tukey HSD Test (Tukey's Honestly Significant Difference Test).

2.4 Ethical Declaration

The present study did not include any contact with the customers and was centred only on the rearrangement of food positioning and display and on the analysis of the purchase of the target food, in this case, no sensitive information was taken in the present study. However, before proceeding with the intervention the project was submitted to the Research Ethics Committee at TU Dublin, Tallaght and also a consent letter from the DCU General Catering Manager was given attesting the purpose of the study and the authorization of the data collection at Trispace Main Restaurant.

Chapter 3:

Results & Discussion

3. RESULTS & DISCUSSION

In this Chapter you will find the results and the discussion of the present study. The first section will present and discuss the descriptive analyses of the data as measures of central tendency, measures of dispersion and graphs for initial visualization of the data. The second part of this chapter will present the results and discussion of ANOVA and the Tukey's test that was used to assess whether the nudges strategies (intervention) increased the units of sales of healthy target foods. Finally it will present if the study reached the aims and the objectives of the present study.

3.1 Descriptive Analyses

The first step was a descriptive analysis of the data as measures of central tendency, measures of dispersion and graphs for initial visualization of the data. The objective of this step of the data analysis process is to check for missing data or some other discrepancy in the data that could influence the subsequent results as commented before.

The total units sold of the target food were collected at 3 different times in order to answer whether or not the use of the nudges strategy was significant for increase sales of the target food in that period. Data was collected for two week periods between the pre-intervention, intervention and post-intervention phases.

It is important to mention that the study had less observation periods than planned. Due to technical issues with the EPOS we were unable to generate the report to show the quantity of sales of target food per day, we had only weekly reports with the total quantity sold in the different periods of the study. It may lead to a limitation and weakness of the study as we have just six observation points, two per each phase (pre, intervention and post). Due to the limited time frame of the thesis research we worked with the data we had.

In the Table 3.1 we can see the descriptive analyses of the units of fresh fruit piece sold in the different phases of the intervention. The intervention period had a standard deviation equal to zero, which shows that in this period there was no variability between the data with a sum of 206 units sold during this period average sales higher than the other two periods.

The post-intervention period had a higher average sales than the pre-intervention period, with an average sales of 69 units and greater data variability also in relation to the pre-intervention period which shows a positive relationship in sales increase for fruit.

Table 3.1 Descriptive analyses of the units of fresh fruit piece sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pd	Sum	Minim	Median	Maxim
Fruit	Pre	65,50	13,44	131,00	56,00	65,50	75,00
	Intervention	103,00	0,0000	206,00	103,00	103,00	103,00
	Post	69,0	15,6	138,0	58,0	69,0	80,0

The Table 3.2 shows the distribution of units of fruit salad sold in the different phases of the intervention. The fruit salad item presented equal values in the intervention period and after the intervention we have a sum of 24 items sold in both periods, with a minimum value of 10 units and a maximum value of 14 units during these two periods.

The average value of the two periods was 12 units with a standard deviation of 2.83, that is, the average value of the units sold 12 oscillated 2 points more or less around the mean.

In the pre-intervention period, the average number of units sold was 7 units of the item

with a standard deviation of 1.41. We can conclude in the case of fruit salad that there was a significant change in sales during the intervention and this change was also maintained in the post-intervention with positive values.

Table 3.2 Descriptive analyses of the units of fruit salad sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Fruit Salad	Pre	7,00	1,41	14,00	6,00	7,00	8,00
	Intervention	12,00	2,83	24,00	10,00	12,00	14,00
	Post	12,00	2,83	24,00	10,00	12,00	14,00

The salad box average sales were higher in the intervention period but little dispersion of the data standard deviation of 1.41 around the sales average, which was 56 units. The average sales decreased in the post-intervention period to 49 units sold but with a higher standard deviation showing a great variability of data in the post-intervention period with minimum values of 33 units and maximum of 65 units.

There was positive results in the intervention period and symmetrical relationship in the data distribution, see details of the data on the Table 3.3.

Table 3.3 Descriptive analyses of the units of the salad box sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Salad Box	Pre	51,00	4,24	102,00	48,00	51,00	54,00
	Intervention	56,00	1,41	112,00	55,00	56,00	57,00
	Post	49,0	22,6	98,0	33,0	49,0	65,0

The Table 3.4 shows that the wholemeal bread had a higher average sales in the pre-intervention period than in the post-intervention period, during the intervention its average sales reached 85 units which was a significant increase compared to the pre-intervention period, however there was a decrease in sales in the period of post-intervention which reached an average of 36 units, a number much lower than in the pre-intervention period.

High standard deviation between the data in both periods and a sharp drop in sales averages between the intervention period and the post-intervention period. These results explain that during the post intervention phase the restaurant was not as busy as the other two phases as it was the graduation week which meant all students were not on campus.

Table 3.4 Descriptive analyses of the units of wholemeal bread sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Whole-meal bread	Pre	59.00	2.83	122,00	57,00	59.00	61.00
	Intervention	85.00	4.24	170,00	82,00	85.00	88.00
	Post	36.00	8.49	72,00	30,00	36.00	42,00

The white bread had an average sales of 81.50 units in its pre intervention period a sum of sale 163 units higher than in the inter-intervention period which had 133 units sold and in the post-intervention period there were 96 units sold.

The standard deviation of the data in the pre-intervention period was smaller than in the post intervention period in that it presented values closer to the average of sales in this period with minimum values of 78 units and maximum value of 85 units. See Table 3.5 with all details of descriptive analyses for the white bread.

These findings suggest that during the intervention phase with nudges in place to increase the sales in wholemeal bread it lead to a significant decrease is sales of white bread. The results of the ANOVA confirmed that white bread presented a significant p value that will be discussed during the analysis of variances.

Table 3.5 Descriptive analyses of the units of white bread sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
White Bread	Pre	81,50	4,95	163,00	78,00	81,50	85,00
	Intervention	66,50	6,36	133,00	62,00	66,50	71,00
	Post	48,00	7,07	96,00	43,00	48,00	53,00

The porridge showed small sales but positive changes in its sales between the pre-intervention and intervention period, the average sales went from 7.50 units to 11 units of the product with a lower standard deviation than the other periods.

During the post-intervention period there was a drop in sales but a non-significant drop to the point of being lower than the average sales of the pre intervention period signalling that in this case of the porridge product the intervention also gave positive results.

Although porridge is not a big seller there are regular porridge eaters who rely on the availability of the product daily and the restaurant encourages healthy eating habits. See below the Table 3.6 for details.

Table 3.6 Descriptive analyses of the units of porridge sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Porridge	Pre	7,50	3,54	15,00	5,00	7,50	10,00
	Intervention	11,00	1,41	22,00	10,00	11,00	12,00
	Post	8,50	4,95	17,00	5,00	8,50	12,00

The soup was another product that had a drop in its sales both in the intervention and in the post-intervention phase. This results show that the average pre-intervention sales (361.5) is higher than in the other two phases as well as the sum of sales which in this period was greater with 723 units versus 390 units in the post-intervention period. See the Table 3.7 for full details.

From the results we can see a large standard deviation of the post-intervention period, there is a large data dispersion ranging from a minimum of 110 units to a maximum value of 280 units. Descriptive characteristics that show that the item soup presented negative results regarding the intervention. These results may be due to the students preferring to opt for special meal deals that took place during this phase, the weather also may have played it's part due to an improvement in temperature and sunshine.

Table 3.7 Descriptive analyses of the units of soup sold in the different phases of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Soup	Pre	361,5	30,4	723,0	340,0	361,5	383,0
	Intervention	307,5	14,8	615,0	297,0	307,5	318,0
	Post	195,0	120,2	390,0	110,0	195,0	280,0

The Table 3.8 shows the distribution of units of popcorn sold in the different phases of the intervention. Popcorn had a higher average sales in the pre-intervention period, totalling 76 units sold in addition to a greater dispersion of its data with a standard deviation of 8.49. In the post-intervention period the average sales dropped to 32 units sold with a variation around the lower average of 4.24.

In the intervention period the standard deviation equals to zero shows that there was no variability during this period and the data remained unchanged. Surprisingly, sales for popcorn were exactly the same for both observational periods during the intervention phase.

Table 3.8 Descriptive analyses of the units of popcorn sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Popcorn	Pre	38,00	8,49	76,00	32,00	38,00	44,00
	Intervention	40,00	0,00000	80,00	40,00	40,000	40,000
	Post	32,00	4,24	64,00	29,00	32,00	35,00

Crisps was the item chose to compare with the popcorn. Crisps showed an increase in sales during the intervention phase but there was a significant drop in the post-intervention phase. There was a higher sales volume in the intervention period with 148 units sold and an average of 74 units. The results show an average and median with equal values in the periods evidencing a symmetrical distribution, see Table 3.9 for full details. As mentioned previously this study may have shown different results if more frequent observation were observed.

In this case the crisps had a positive result in terms of post-intervention sales, with an average sales of 40 units well below the pre-intervention period, but, as previously reported in the post intervention phase the sales was slightly down comparing to the intervention two week phase.

Table 3.9 Descriptive analyses of the units of crisps sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Crisps	Pre	64,50	9,19	129,00	58,00	64,50	71,00
	Intervention	74,00	9,90	148,00	67,00	74,00	81,00
	Post	40,0	14,1	80,0	30,0	40,0	50,0

The Table 3.10 present the results for mixed nuts. Mixed nuts had a slight but positive result in sales since the beginning of the intervention. The average sales increased from 11 units to 12.50 units in the intervention period and increases in the post-intervention period. Higher standard deviations in the intervention period and after means and medians with equal values showing a symmetrical distribution again in the study.

Table 3.10 Descriptive analyses of the units of Mixed Nuts sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Mixed Nuts	Pre	11,00	1,41	22,00	10,00	11,00	12,00
	Intervention	12,50	9,19	25,00	6,00	12,50	19,00
	Post	14,50	7,78	29,00	9,00	14,50	20,00

The chocolate bar had a higher sum of sales in the pre-intervention period with a total of 498 units sold versus 370 in the post-intervention period. In the intervention period the average sales was 214.50 units but with a much lower standard deviation (2.12) than in the other two phases which presented a high standard of deviations of 25.5 and 21.2 which indicates greater variation around the mean, see Table 3.11 with details.

In this case the study showed positive results as it was expected to reduce the consumption of chocolate bars and increase the consumption of mixed nuts. The mixed nuts had a slight increase of 14 % in the intervention phase compering to the pre intervention. As other studies carried out show checkout areas are complex sales points due to multiple offers suggesting that more studies should be carried out and compared with the findings here.

Table 3.11 Descriptive analyses of the units of chocolate bar sold in the different phase of the intervention.

Variable	Phases	Mean	Dev Pad	Sum	Minimum	Median	Maximum
Chocolate Bar	Pre	249,0	25,5	498,0	231,0	249,0	267,0
	Interven-tion	214,50	2,12	429,00	213,00	214,50	216,00
	Post	185,0	21,2	370,0	170,0	185,0	200,0

3.1.2 Quantity of Target Food Sales per Phase

The bar graphs on the Figure 3.1 show the sales of each target food during the pre interventional phase.

Based on the charts' findings it shows the best sellers of the target foods in the pre intervention phase are as follows; the highest healthy target food sales was soup with 615 units sold, the fruit was in second place with 206 units sold followed by wholemeal bread with 170 units.

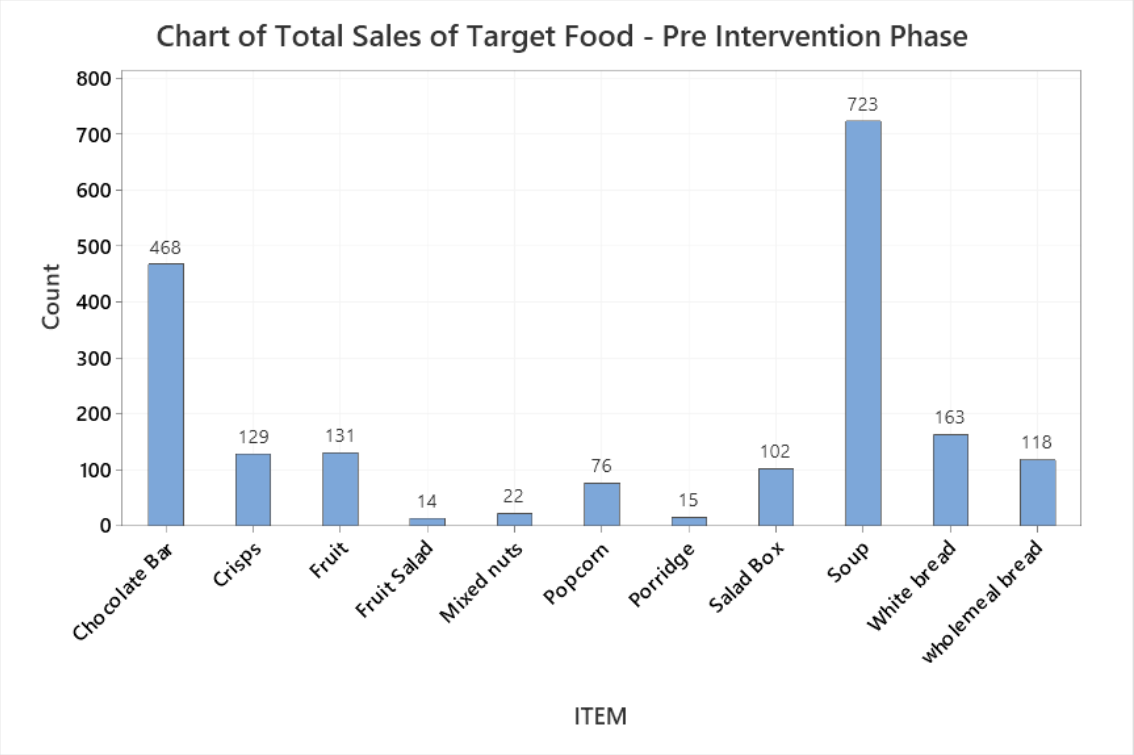

Figure 3.1 Total sales of the target food during the pre intervention phase

During the intervention it was noted that the higher target food sales is still soup but there was a decrease in the sales unit number of the product. Also shown in the Figure 3.2, the an increase in sales of other target food products such as the wholemeal bread, fresh fruit piece which all had an increase. White bread sales declined in this period showing this intervention increased the sales in the target healthy food (wholemeal bread) and decreased the sales of the lesser healthy food (white bread).

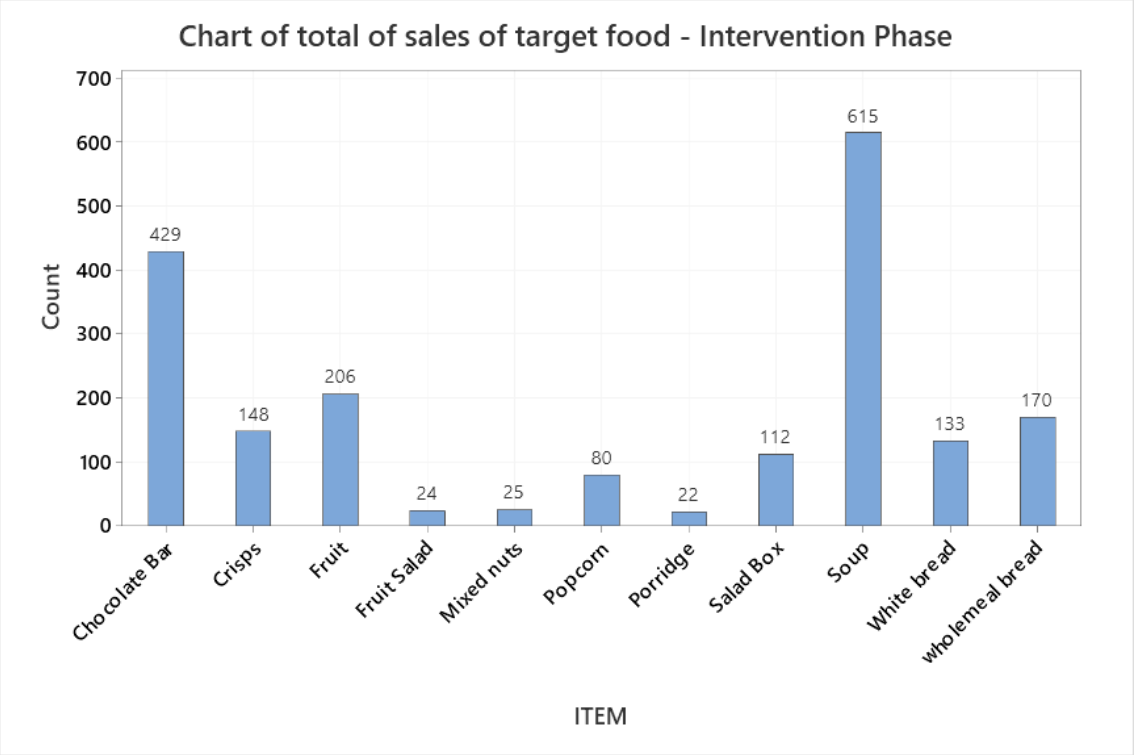

Figure 3.2 Total sales of the target food during the intervention phase

In the post intervention phase, there was an overall drop in sales during the post intervention phase versus the intervention phase but this drop in sales did not reduce to the pre-intervention sales values indicating that there was a positive change after the intervention. See Figure 3.3 with the total sales of the target food per unit during the post intervention phase.

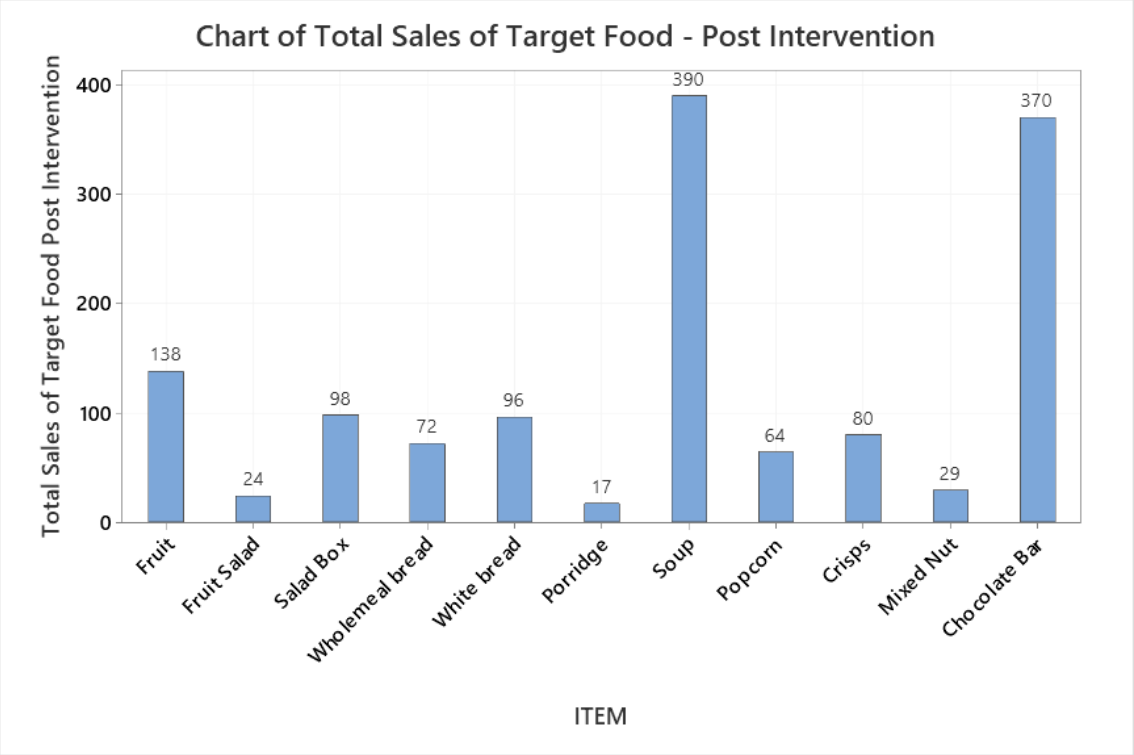

Figure 3.3 Total sales of the target food during the post intervention phase

Through ANOVA analysis of variance, it will be possible to verify whether or not there was a significant increase in sales and whether this increase was maintained after the intervention.

3.2 Analise of assumptions of ANOVA

Before the one-way ANOVA was conducted, it was checked for the three aassumptions for a valid ANOVA test: data needs to be normal, random and with equal variance on all levels. Table 3.12 was created with the assumptions for each target food.

The ANOVA accepts that each sample was formulated from a normally distributed population. To check this assumption, it was visually checked all histograms for each food and the residual analysis shown in the normal probability plot (points close to the line). See Appendix 2 with all graphs.

Random sampling is used in statistics to make generalizations or inferences about a population. In the case of this study, the observations within each group were obtained by a random sample. To check this assumption, it was visually checked the Versus Fits plot to see if the randomness is met for each target food.

The variance and the standard deviation are used to measure the dispersion of the data, a high value of variance indicates values that are far from the mean. In this study, analysis of variance was used on all variables to measure how far the data was from the mean. ANOVA assumes that the variances of the populations that the samples come from are equal. We analysed the boxplot of each target food to check this assumption, see appendix 2 with all boxplot. The variance of sales of the target food can be seen in the boxplot. The longer the box, the higher the variance.

Table 3.12 Analyses of the assumptions of ANOVA for each target food.

	Assumptions		
Target Food	**Normal**	**Random**	**Equal Variance**
Fresh fruit	YES	YES	NO
Fruit salad	YES	YES	NO
Salad box	YES	YES	NO
Wholemeal bread	YES	YES	NO
White bread	YES	YES	YES
Porridge	YES	YES	NO
Soup	YES	YES	NO
Popcorn	YES	YES	NO
Crisps	YES	YES	NO
Mixed nuts	YES	YES	NO
Chocolate bar	YES	YES	NO

After checking the assumptions of ANOVA we can considered that the assumptions are sufficiently met and analysis can be considered valid.

3.3 Analysis of Variance

To evaluate if the number of target foods increased as result of the nudging interventions a series of analysis of variance (ANOVA) was ran to compare the sales of the target foods during the pre-intervention, intervention and post intervention phases.

To find out if each target food had increased the sales after the intervention the One Away ANOVA was conducted repeating the same analysis separately for each specific target food (fruit salad, fruit, porridge, soup, wholemeal bread, white bread, popcorn, crisps, mixed nuts, chocolate bar and salad bowl). In total 11 One Way ANOVA were executed, one for each target food. See appendix 3 for full report of the One Way ANOVA for each food.

H0= Nudge strategies **has no effect** on increase of sales of healthier target food

H1=Nudges strategies **has effect** on increase sales of healthier target food

A One-way ANOVA was performed to compare the effect of the use of the nudge strategies on sales (per unit) of the target food in the different phases of the study. See Table 3.13 for the P-Value, F- Value and R-sq for all the target food in the present study.

Table 3.13 One Way ANOVA for each food with P-value, F-value and R-sq

Product	*P- Value	F- Value	R-sq
Fresh Fruit	0,088	6,09	80,25%
Fruit Salad	0,208	2,78	64,94%
Salad Box	0,869	0,15	8,90%
Wholemeal Bread	**0.008**	**36.80**	**96.08%**
White Bread	**0,028**	**14,69**	**90,74%**
Porridge	0,65	0,5	25,00%
Soup	0,208	2.78	64,92%
Popcorn	0,425	1,16	43,51%
Crisps	0,115	4,83	76,29%
Mixed Nuts	0,886	0,13	7,74%
Chocolate Bar	0,097	5,58	78,83

* p-Value $\leq \alpha$ – $\alpha = 0.05$

The p-value is a likelihood that indicates the strength of the evidence against the null hypothesis. Lower likelihood provide stronger evidence against the null hypothesis. In this case, the p-Value $\leq \alpha$: were for the wholemeal bread and white bread products that presented values of 0.008 and 0.028, that is, the variables present a statistically significant association. The closer to 0 the more significant the variable.

The other products presented a value of $p > \alpha$, that is, we must reject the null hypothesis because there is not enough evidence to conclude that the variables are associated.

We can determine if the test is statistically significant with the analysis of the F test. The F value is used in the analysis of variance (ANOVA) and is used to determine the significance for the test. We have the F statistic values of 36.80 for wholemeal bread and 14.69 for white bread, that is, the higher the F value, the more significant the variable.

R2 represents the percentage of variation in the response that is explained by the model the higher the value of R2 the better the model fits its data. The value of R2 is always between 0 and 100%. In this study it showed that only wholemeal bread with 96.08% and white bread with 90.74% , that is, the model fits better to the data of these two variables. See this adjustment in the Figures 3.4.

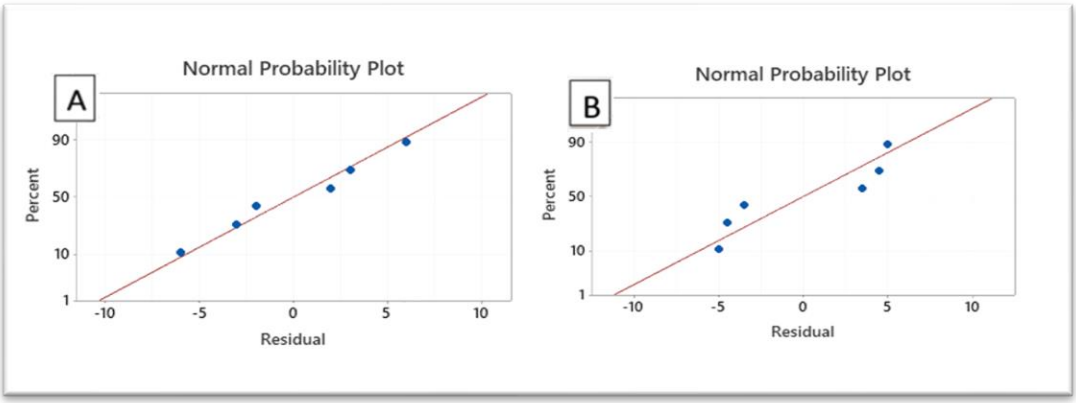

Figure 3.4 Regression model of the variance of the wholemeal bread (A) and white bread (B).

Above is a simple regression model that explains 93.49% of the variance in wholemeal bread's response and 90.74% in white bread. The more the points decay on the line, the greater the variation is explained by the model.

Table 3.14 Grouping information using the Tukey Method and 95% Confidence

Phase	N	Mean	Grouping	
Pre Intervention	2	59.00		B
Intervention	2	85.00	A	
Post Intervention	2	36.00		B

The pre-intervention phase has an average that shares a letter with the other groups, so, they are not statistically significant. The intervention does not share any letter, it is significantly different, we can see that the intervention period has a higher average than the post intervention phase.

The confidence interval for the difference in mean values between the intervention and pre-intervention phases excludes zero, indicating that the difference is statistically significant. The Intervention and Post Intervention phases were comparable, indicating that the difference is statistically significant. The other results include zero, indicating that the differences between the groups are not statistically significant, as illustrated in Figure 3.5.

The Table 3.15 indicates that the individual confidence level is 97.50%. This result indicates that it is possible to be 98.89% confident that each individual interval contains the true difference between a specific pair of group means.

Table 3.15 Tukey simultaneous tests for differences of means

Difference of Levels	Difference of Means	SE of Difference	95% CI	T-Value	Adjusted P-Value
Pre / Intervention	26.00	5.72	(2.12, 49.88)	4.55	0.040
Pre / Post	-23.00	5.72	(-46.88, 0.88)	-4.02	0.055
Intervention / Post	-49.00	5.72	(-72.88, -25.12)	-8.57	0.007

Individual confidence level = 97.50%

Through the Figure 3.5 above we can see that the first period that corresponds to the pre-intervention and intervention does not include zero, which indicates that the difference is statistically significant.

In the second phase, which corresponds to the pre-intervention and post-intervention period, they have a value of 0 , that is, not significant.

The third phase, which corresponds to the intervention and post-intervention period, does not include the value of 0 , that is, this period was also indeed significant for wholemeal bread.

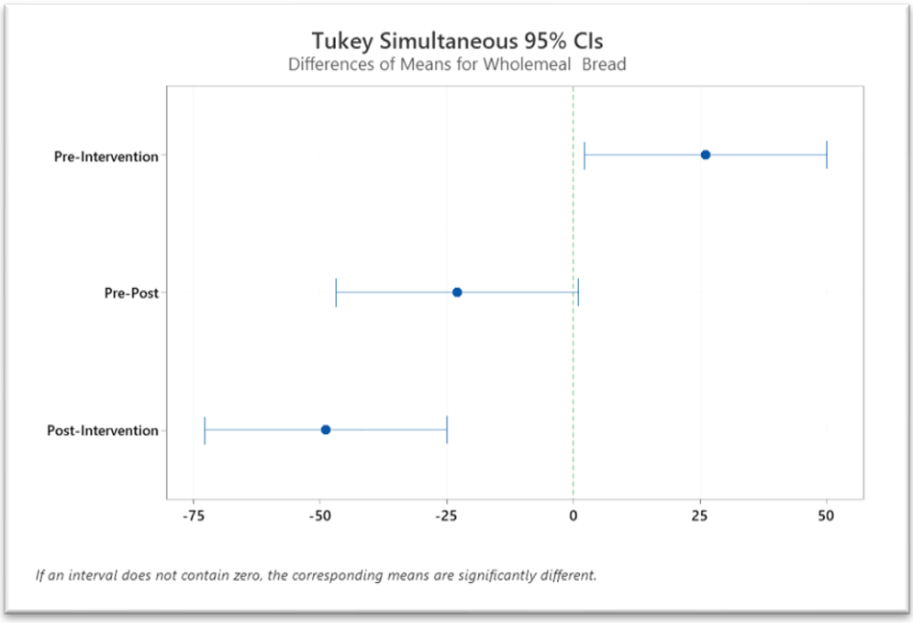

Figure 3.5 Tukey Simultaneous 95% - Differences of means for wholemeal bread in the differences phases of the study.

The Figure 3.6 shows that the Interval Plot of the wholemeal bread presented a higher average in the intervention period.

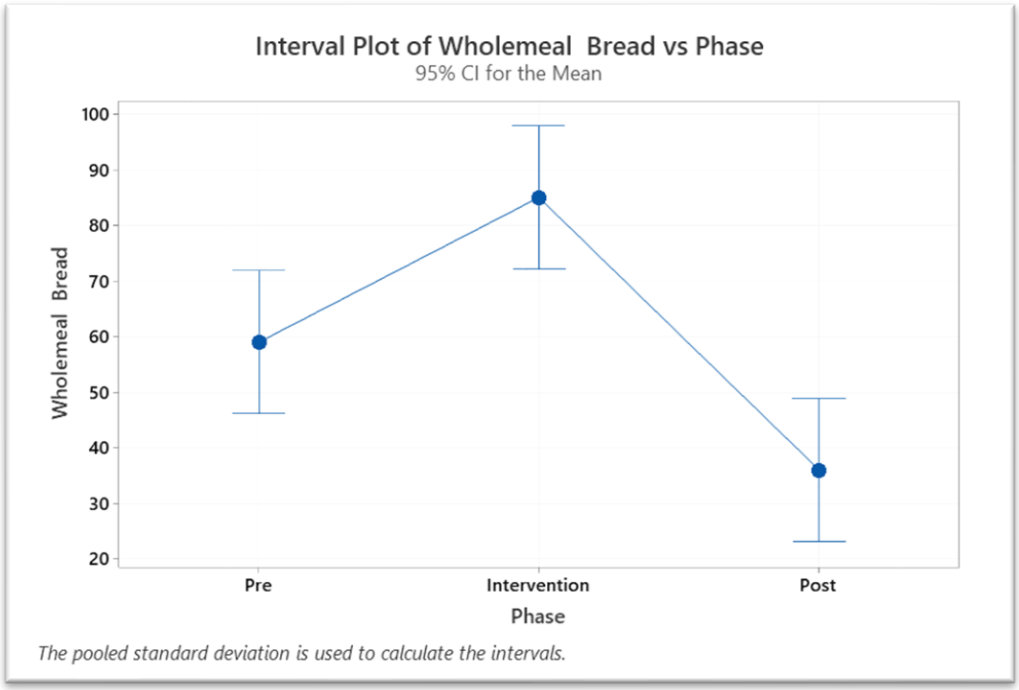

Figure 3.6 Interval Plot of the wholemeal bread during Pre Intervention, Intervention and Post Intervention.

3.4 Did the Nudge Strategies Work for Each Target Food?

The one way ANOVA showed that the only p-Value ≤ α: was for the wholemeal bread and white bread products that presented values of 0.008 and 0.028, that is, the variables present a statistically significant association.

The white bread was target to compare against the wholemeal bread, the Tukey test for differences of means revealed that the mean of units sold of the white bread in the pre intervention was 81.50 units while in the post intervention it had a decreased to 48 units

only. The test also showed statistically significance only for the Post / Pre Intervention group with an Adjusted P-Value of 0.025, in contrast, the wholemeal bread had a strong association with the Pre and Intervention phase with an increase of 44.5% of units sold. It was also clear the association between the intervention phase and post intervention as the wholemeal bread dropped the sales of 170 units sold during intervention to 70 units sold in the post intervention phase.

The overall results suggest two things; it can be assumed that the increase of wholemeal bread sales during the intervention phase was a result of the nudes strategies by offering the product at additional counters and displaying the icon "Good for you" on the counters. The drop in sales of wholemeal bread during the post intervention phase may be associated to the overall reduction of sales in the restaurant during the post intervention week.

The results analysed include pre intervention, intervention and post-intervention data, it shows a more expressive sale of the wholemeal bread food item during the intervention period with a decrease in this behaviour during the post-intervention period, see Figure 3.7 for full details. A potential scenario for the increase of the wholemeal bread during the intervention period may be due to the nudges intervention as the wholemeal bread was displayed in front of the white bread with a raise under the container, sales were also prompted by displaying the icon "Good for you" beside the wholemeal bread.

The findings here support the findings of Cesareo *et al*. (2022), in the nudge intervention. Among Italian university students they found out that the wholemeal bread was the target food that the intervention with nudges worked for the best ($F= 137.21$, $P <.001$) increasing the selection of the wholemeal bread by 35.% over the white bread and the effectiveness also was not affected by the different menus/offers available.

Regarding the nudges strategies Cesareo *et al*. (2022), used two different nudge strategies: (1) increasing ease/convenience by placing the wholemeal bread near the trays and the white bread they positioned slightly greater distance from the trays, (2) Providing disclosure the author used a label symbol of a hand holding a fork to make the whole bread options more prominent. Therefore, it is reasonable to assume that the nudges

strategies lead to a significant increase of consumption of wholemeal bread between consumers of university restaurant in both studies.

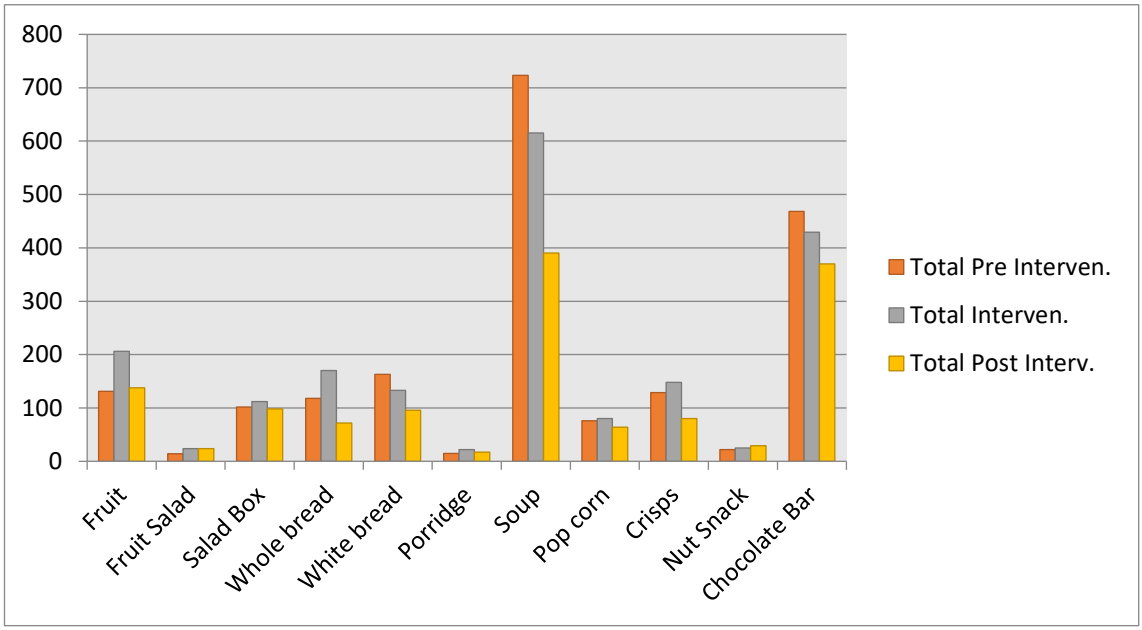

Figure 3.7 Total of units of target food sold during the phases of the intervention.

As showed in the Figure 3.4 the best-selling product of the house is the item soup which showed a decrease in sales both during the intervention and post intervention which is a result against the effectiveness of the nudges. There were two nudges strategies used to promote the sales of the soup, one, a poster to using priming nudge strategy and secondly a “Good for you” icon item beside the soup kettle. In this case the nudges did not work. It suggests that in the case of the soup the nudges strategies need further work to find out the right nudge strategies required that may or may not work to encourage soup sales.

The salad box and fresh fruit were the items that showed a significant increase in the intervention which indicates the nudges interventions helped to increase the sales for these products despite not presenting significant statistics on the analysis of variances. The fruit presented a 59% increase of units sold during the intervention week comparing to the pre intervention phase.

The current study applied three different nudges strategies for the fresh fruit pieces;

One of the strategies was the ease and increasing convenience, in this case we spread bowls of fruit in strategic points of the restaurant, such as the buffet area where students queue to get the meals and also near the checkout where students queue to pay and can make last minute, impulse purchases just as they are paying for the meal.

Secondly “Good for you” icon signs were displayed to provide disclosures and lastly an A3 poster was displayed outlining the health benefits of the fruit. See appendix 3 with pictures of the fruit bowls and posters.

The findings here support the findings of Cesareo *et al*. (2022) also target fresh fruit did not have a significative p-value (non-significant interaction effect). However we believe that in case of fruit that our findings would be more significant it had more observational periods to compare. Due to the technical issues with the EPOS system and the thesis time frame the daily data could not be collected on a daily basis and so the results that were available (weekly) were used in the analysis.

Kongsbak *et al.* (2016), in the university restaurant of Aalborg University the study did not present significant difference in the total amount of self-served fruit and vegetables between the control group and the nudges intervention group, however, they found that by using nudge strategies as such offering the fruits and the vegetables in eight separate bowls in the buffet service increased the quantity of self-served item and therefore decreased the total energy intake.

Thorndike *et al*. (2017), also found out that the sales of fruits and vegetables were increased by increasing the visibility (nudge strategy) of the target product. The author compared the sales trend from the baseline with the intervention period (five months). However, in this study they had a control store to compare with. When the author compare the total sales of the fruit and vegetable with the control store with the store with the customer intervention they were not statistically significant, this was similar to the current study results.

Bender *et al.* (2016) compared the sales of fruit against the sales of dessert in 11 university restaurants, the intervention consisted in pre and post analyses of the data sales with a four week period of intervention and 4 weeks sales of baseline. It was found that seven out of the eleven restaurants held the increase of sales for fruit and decreased of sales for others dessert options. Like our study it is a heterogenic result and the study used 3 different nudges strategies to promote fruit consumption, (1) increasing or decreasing ease/convenience; (2) attracting or reducing attention and (3) priming. All the same strategies were used in both studies, however they had a intervention based on four weeks observations while our intervention had two weeks of observations for each period.

The fruit salad was a product that two different nudges strategies were applied, priming and using disclosures. A new label was used with nutritional information for the item and also priming with the icon "Good for you". In the pre intervention period, the average number of units sold was 7 units of the item with a standard deviation of 1.41 while in the intervention phase the average value was 12 units with a standard deviation of 2.83, that is, the average value of the units sold 12 oscillated 2 points more or less around the mean. The conclusion is that the fruit salad had an significant change in sales during the intervention and this change was also maintained in the post-intervention with positive values, however, the fruit salad had no significant effect on sales on the analysis of variance.

There is an increased of study assessing the effect of nutrition labelling of pre-packed food as a strategy to promote public health nutrition (Cioffi *et al.*, 2015, Ni Mhurchu *et al*., 2018, Sacks *et al*., 2009). Cioffi et al. (2015) conducted a study with nutrition label intervention (disclosure e nudge strategy) in a University dining setting to find out if the nutrition information labels would have any effect on sales and increase/decrease calories consumption. Based on daily sales The proportion of sales from low-calorie and low-fat foods increased significantly (p0.001), while the proportion of sales from high-calorie and high-fat foods decreased significantly (p0.001). The findings indicate that placing nutrition labels on pre-packaged foods in a large university dining hall results in a small but significant decrease in the purchase of labelled high-calorie, high-fat foods and an increase in low-calorie, low-fat foods.

As discussed before the fruit salad had an significant change in sales during the intervention and this change was also maintained in the post-intervention with positive values, but the was no significance results. However, Ni Mhurchu *et al*. (2018) conducted a four week intervention with the aim to find out if nutrition labels influence healthier food choices. The author found a strong significant association between the use of the labels in pre packed food and the sales of healthier food. It is possible to postulate that in the present study the use of nudge as descriptive labelling needs a deeper understanding of how nutritional labelling can affect the healthy eating and it was not possible to have a clear conclusion of the effect of the nutritional labelling due the lack of fruit salad as reported earlier in the discussion.

As reviewed in the introduction nudges are being increased use as a strategy to promote healthy eating. As a study a supermarket in central London set itself the goal of organizing the order of things, presenting a temporary store in which customers were brought to make better decisions for healthier eating. Obviously, there is a clear reference to the theory developed by the Nobel laureates Thaler and Sunstein, which inspired the philosophy of the supermarket: if compulsive buying must be, at least it is as healthy as possible.

The results for the target food at the checkout area was mixed and even controversial. The popcorn was placed in front of the crisps and at a higher level and near to the customer yet the crisps had an increase of 14.3% in sales during the intervention period which means the opposite effect to what we expected with the nudge intervention. The findings here are against the findings by Hunter *et al*.(2019) that support the claim that relocating food further away reduces the likelihood of consumption in general populations and that this effect is unlikely to be moderated by cognitive resources. Beside the crisps not decrease sales the popcorn had a slight increase of 5.5%.

Similar results occurred for the chocolate bar which had a significant increase in its sales compared with the results of sales of the healthier options being the packet of mixed nuts. Based on previous studies of proximity and multiple choices Van Gestel *et al*. (2020) suggests that the checkout area has multiple alternative options, there is a need for more

systematic studies in a real environment to find out the effectiveness of the nudge in a complex situation with multiple options like the checkout area.

Beside this study which had a heterogenic results regarding the target food at the checkout area, other studies revealed different results as the study conducted by Kroese *et al*. (2016) had an significant increase, by displaying the healthier snack with disclosures at the checkout area the sales nearly doubled for the healthier snacks options (287 versus 161). In the same setting Van Gestel *et al.* (2017) assessed the sales of healthy food in the checkout area and the healthy food products sales data increased ($F\ (1,\ 54) = 38.15$, $p < .001$).

It is important to mention that in the both studies the author left just the healthier choices at the checkout area and spread the unhealthy choices around the shop, the restaurant in the study does not allow this kind of the strategy as a large array of different food and the snacks such as chocolate and crisps are displayed at the checkout points.

Cardario and Chandon, (2020) revealed that nudges intervention are more effective at reducing unhealthy eating than they are at improving healthy eating or decreasing total eating, they found out that reducing unhealthy eating has a 30% larger effect size than increasing healthy eating. The presented results here had similar results when comparing the chocolate bar and the mixed nuts. Second Schwartz *et al*. (2014) reported that irregular preferences and self-control lapses may help to clarify why individuals would welcome interventions that help them avoid unhealthy eating and help them stick to their long-term goals without feeling guilty.

When the topic is food display the bigger brand chains are famous for placing their premium product in the best position in the shop, brands like Coca-Cola, for example, pay more money or offer more benefits to stay positioned in the corner and premium locations, which can indicate some connections between high consumption of certain types of food and their location in the aisles. More data need to be analysed in that perspective and tests replicated, but considering humans behaviour in general and marketing strategy applied in the supermarket industry some connections can be

established.

The present study aims to assess if the use of nudges strategies can increase customers' healthier food choices. The results presented here indicates that the use of nudge strategy promoted an increase of healthier food choices among the users of the university restaurant. Nevertheless, is not clear that these results for certain target foods such as soup that had a decrease in sales during the intervention and post intervention. Crisps also was compared with popcorn and had higher sales during the intervention, so nudges did not work for these items, however, there was an increase of the majority of the target food item but during the analysis of variance the majority of the target food items did not present statistical significance therefore we believe if we have more observational periods we could get more robust results and may find significance.

Objective 1. To find out which nudge strategy work the best in the present study.

In the present study the nudges strategies that work the best were the priming, ease/convenience and disclosures. as we used it to improve the sales of wholemeal bread, fruit and fruit salad. It is important to mention that only the wholemeal bread showed statistically significance, however the sales of fruit increase by 59% in the intervention phase compering to the post intervention phase. The fruit salad also had an increase in sales during the intervention phase. The other target food needs further study as the result are heterogenic and inconsistent.

Objective 2. To find out if the nudge strategies are an efficient intervention to be transferable to other Trispace restaurants/cafes

The study concludes that the nudges strategies can be an effective tool to be transferable to other Trispace outlets, as it help increase the sales of target healthy food and also

decrease the sales of lesser healthy options. It is also important to mention that the university restaurants may be the ideal setting to apply such intervention as nudge, due the wide range of options and also the target populations is mainly young adulthood who are willing to learn and whose eating habits can still be changed or shaped.

The results presented here indicates that the study promoted an increase of healthier food choices among the users of the university restaurant. Nevertheless is not clear the results for certain target food in the present study such as soup that had a decreased on sales during the intervention and post intervention. Crisps were compare with popcorn and had higher sales during the intervention so nudges did not work for this item, however, there was an increase in the majority of the target food. They did not have statistical significance therefore we believe if we have more observational periods we could get more robust results and may find statistically significance for other target food.

Chapter 4:

Conclusion and Future Work

4. CONCLUSION AND FUTURE WORK

This chapter will conclude and summarise the critical results, impact and contributions of the study. Additionally, it will present the limitations of the study and suggestions to address the limitations found. Finally, it will propose areas of future work and make recommendations on how this may be carried out in the future.

4.1 Conclusion

While a variety of factors contribute to the development of morbidity and mortality, daily choices, such as food choices can also have a significant impact on long-term health deterioration. However, changing well-rooted habits such as eating habits is difficult, even more so because of the numerous factors that are intrinsically linked to food choices. Even so, daily food choices represent a critical opportunity to improve people's health.

The present study makes some significant contributions to the literature. To begin, this study contributes with empirical evidences that can assist academics and practitioners in developing additional nudge strategies for university restaurants. The study highlights extra knowledge to make new interventions based on the findings of the present study. However, it is important to mention that additional research should be conducted in similar settings to determine whether comparable findings can be obtained.

Secondly, as far as it was known it is one of the first studies to examine the effectiveness of a nudge strategy aimed at encouraging healthy food choices in an Irish university restaurant. University restaurants may be the ideal setting for people to make decisions because they have a wide range of options and also the target populations is mainly young adulthood who are willing to learn and whose eating habits can still be changed or shaped.

Additionally, we agree with Arnot and Thomas (2016)'s conclusion that nudge strategies can be used as a tool to encourage healthy dietary behaviours. As the literature review

pointed nudges strategies has many classification and it is hard to compare the effectiveness of the studies. In this case the governments and policy-making organizations should evaluate the implementation of nudge on the basis of strong research and create a clear and transparent instrument that can be applied across multiple fields, Therefore been transparent about the intervention may alleviate concerns about the ethics of behaviour manipulation.

To summarize, the study highlights the limitations of nudges and reminds us that they are not a solution. While nudges can be an effective and low-cost technique for changing individual behaviours, it's critical to keep in mind that not all behaviours are equally easy to alter. As reported by Ensaff (2021) understand the importance of using a scientific foundation when working with behaviour change interventions, and sensible theory provides a solid groundwork of how and why nudge strategies may work, therefore, behavioural science can continue to grow allowing for possibilities to lead to better outcomes across different sectors.

4.2 Limitations and Future Work

The study's conclusions should be interpreted in terms of its limitations. There were four limitations;

The first limitation of the study was that we did not have access to the daily sales report. Due to a technical issue, the EPO system did not run the daily sales per unit which led the study to have fewer observational periods than planned and limitations in the statistical analyses. We suggest that when the EPOS system is fully working to run a new analyses with the daily sales as we can have a clear picture to see if there is any effect of the days of the week and the intervention.

Secondly, another limitation was the time of year in which the study was developed, this year, as a result of COIVD 19, the university had two graduation ceremonies scheduled in the academic calendar, one in late February and another in late March and as a result

of changing the students; schedule reducing the numbers present on campus it was impossible to conduct the study without being impacted by the graduation; in this case, due to the thesis's limited time frame, the final week of the post intervention phase was impacted by the March graduation, resulting in a quieter week and potentially limiting the ability to assess the overall impact between the intervention and post intervention phases effectively. In light of this constraint, future studies should be conducted during the months of September and October, as there are no graduations, study weeks, reading weeks or other events that would affect the restaurant's sales volume.

It should be mentioned the lack of the target food products available to sell. Stocks ran out of fresh fruit salad during 1.5 days of the intervention period due to the supplier's shortness of fresh fruit salad. Fresh fruit salad is not a popular product and the sales level is quite low, however, it is a very healthy food, rich in protective nutrients that help protect against heart disease and some cancers, it is also low in calories and help prevent body weight gain so it is good to promote and increase the sales of the fresh fruit salad. The nudge intervention had a weak effect on sales and suggests that these results may be slightly affected due to lack of availability. This limitations was observed in other study where there was a lack of second course (Cesareo *et al.*, 2022). A backup supplier for the target food would be a suggestion to over come the present limitation of lack of product.

The last limitation mentioned would be the COVID 19 pandemic. During the COVID 19 the restaurant was operating with disposable food containers which was a barrier for the present study as food such as vegetables (side dish) could not be targeted due to the impossibility of identifying the target food at the checkout and entering the target food accordingly at the EPOS system. To overcome this limitation the researcher recommends future studies to check if nudge strategies can increase consumption of vegetables as a side dish.

Although there were limitations the results of this current study were positive given that it was the first study in an Irish university to use nudge strategy to promote healthy eating.

With such a broad selection of nudge strategies to examine, it would be worthwhile to conduct additional research with targeted interventions for the consumption of foods such

as snacks (mixed nuts, popcorn) sold at checkout areas with multiple and complex choices, with the goal of determining which nudge strategies work best for this food category.

Additionally, there is a need for a better understanding of how people react to being nudged or somehow influenced. In this context, it would be important that future research include a questionnaire to establish the true causes of the increase or decrease in the target food consumption, as well as whether or not the customer was receptive to the nudge intervention, as it would clarify some ethical aspects of nudge and lead one step further to implement transparent nudge strategies across other domains.

Chapter 5

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5. References

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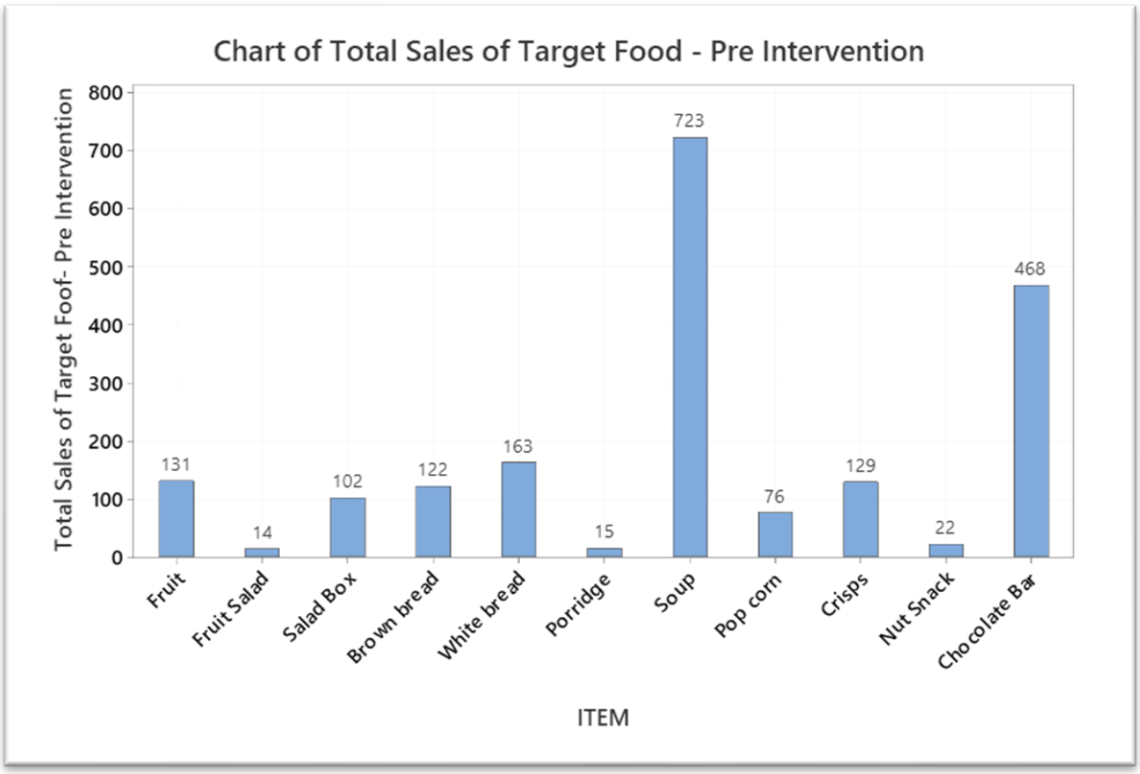
Appendix 1

Quantity of Target Food Sales per Phase

Apendix 1

Quantity of Target Food Sales per Phase

Figure3.1 Total sales of the target food during the Pre Intervention Phase



Appendix 1

Quantity of Target Food Sales per Phase

Figure3.2 Total sales of the target food during the Intervention Phase

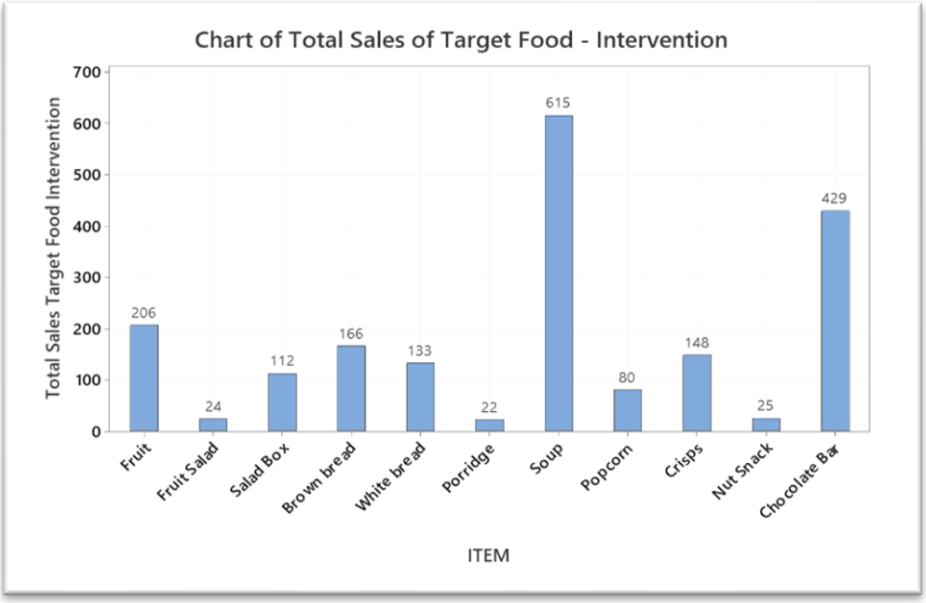


Figure3.3 Total sales of the target food during the Post Intervention Phase

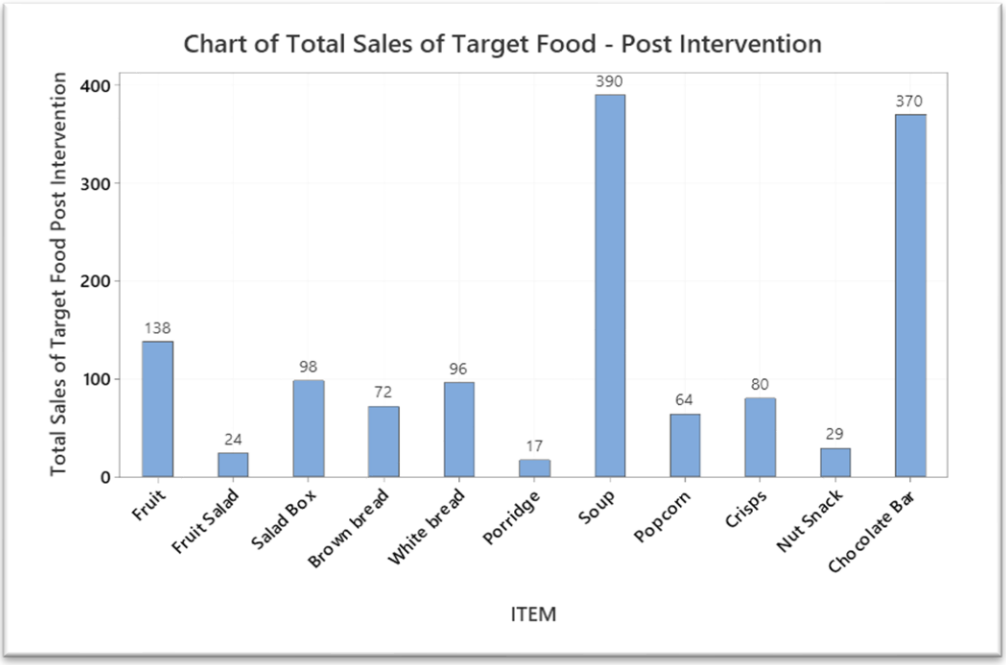
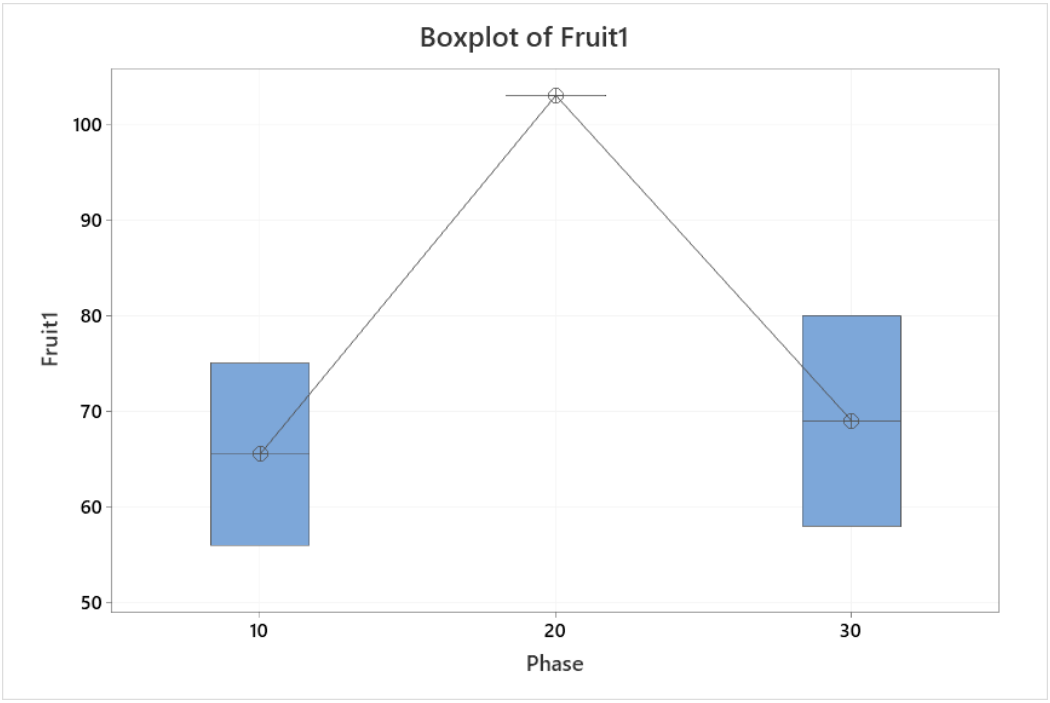


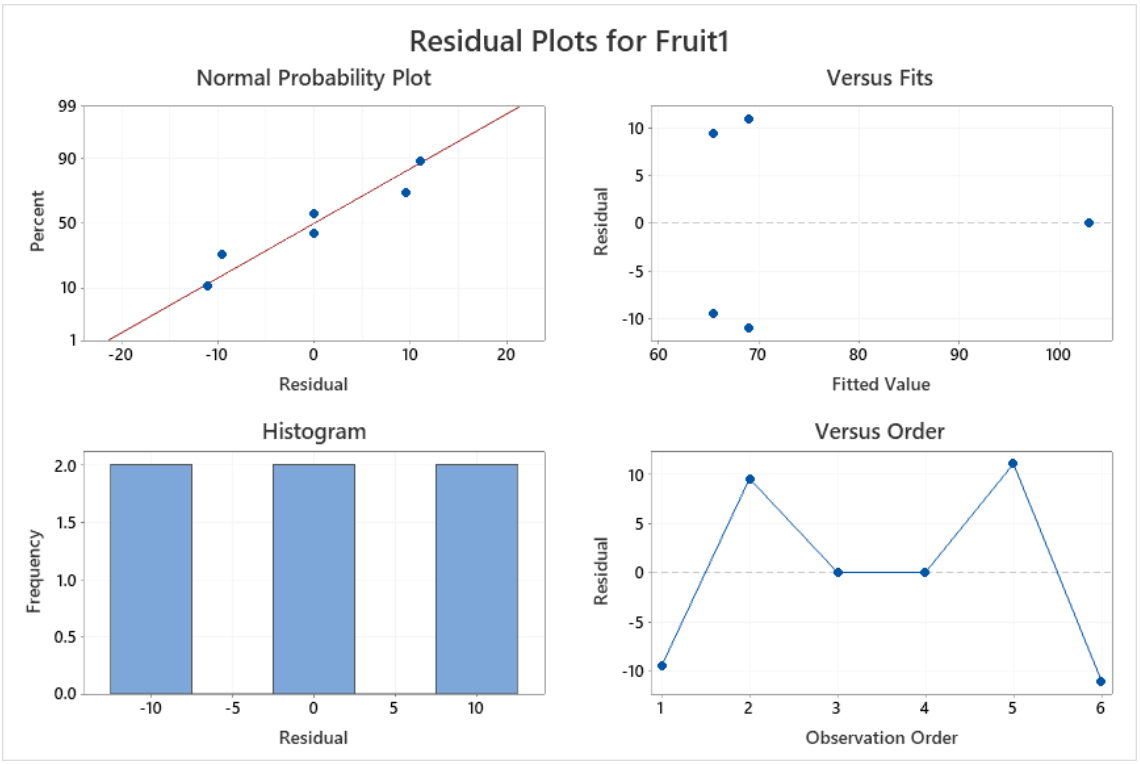
Chart of Total Sales of Target Food - Post Intervention
Total Sales of Target Food Post Intervention
400
300
200
100
0
138
24
98
72
96
17
390
64
80
29
370
Fruit
Fruit Salad
Salad Box
Brown bread
White bread
Porridge
Soup
Popcorn
Crisps
Nut Snack
Chocolate Bar
ITEM

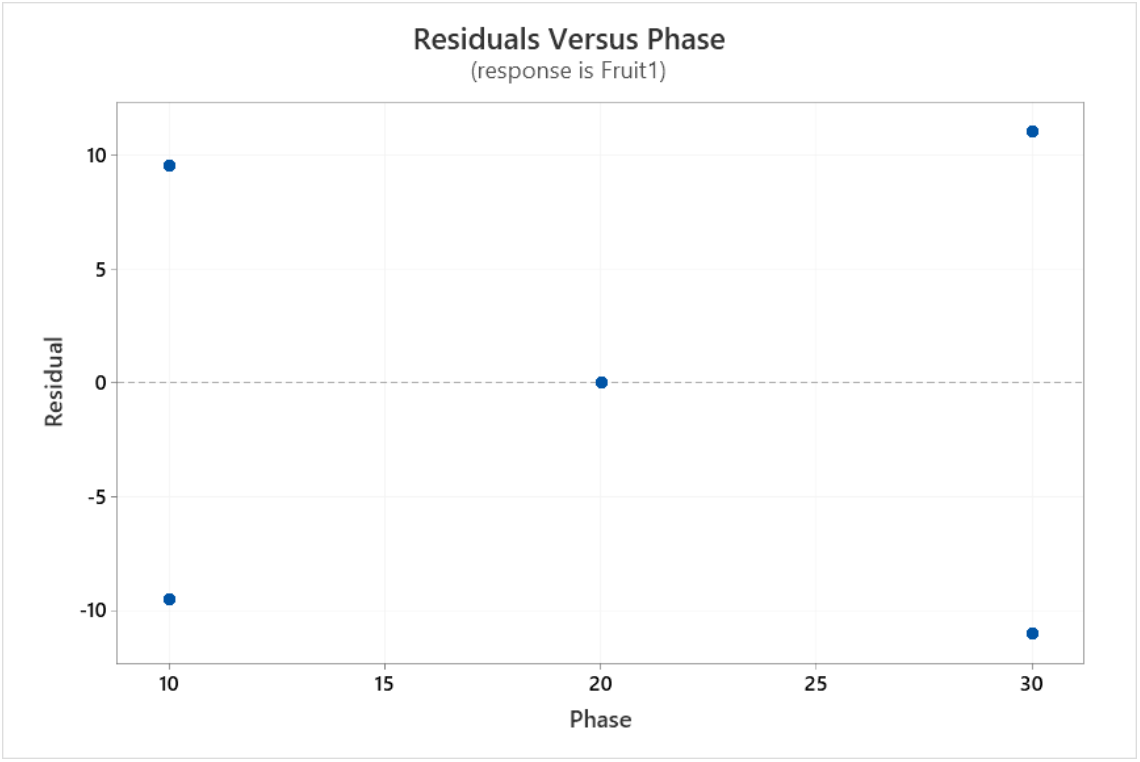
Appendix 2

Graphs for analyse of assumptions of ANOVA

Apendix 2 Graphs for analise of assumptions of ANOVA *Fruit*

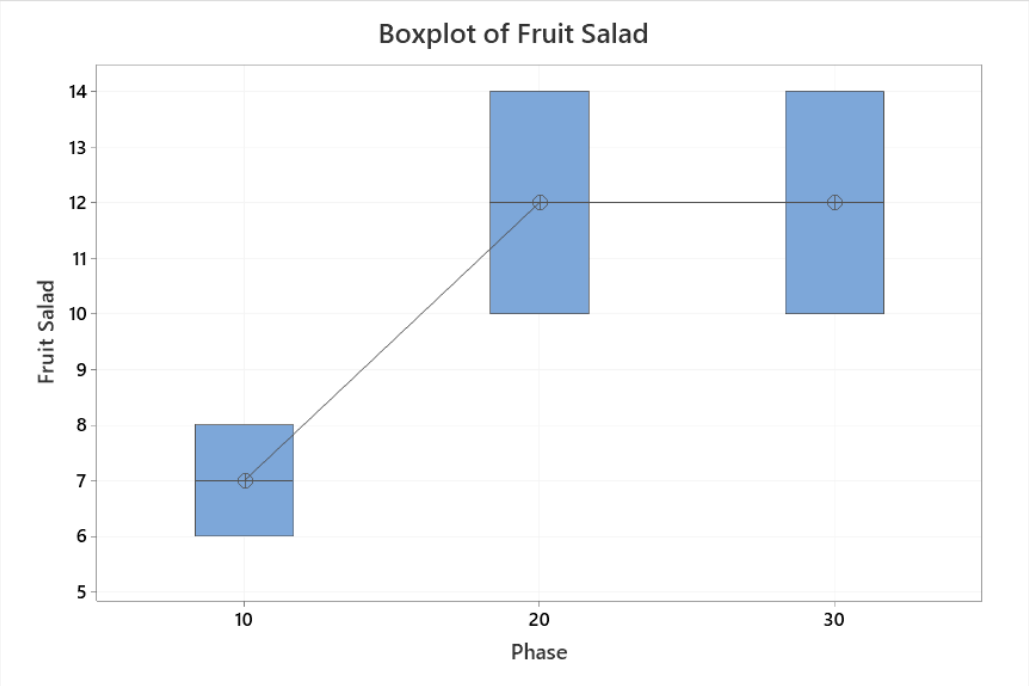


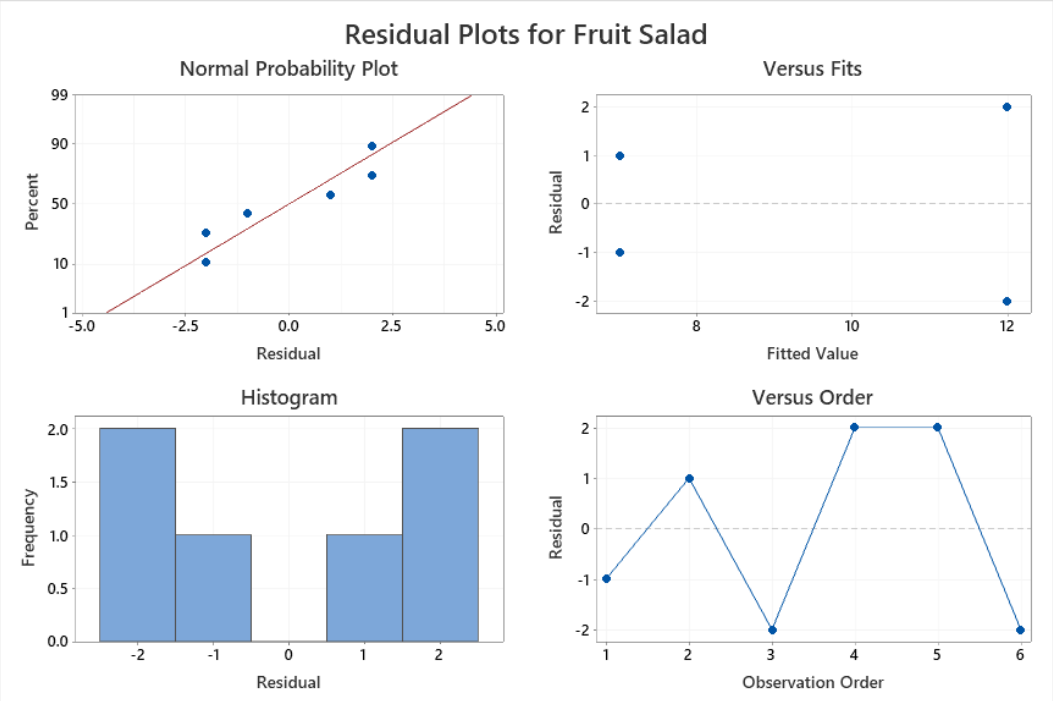


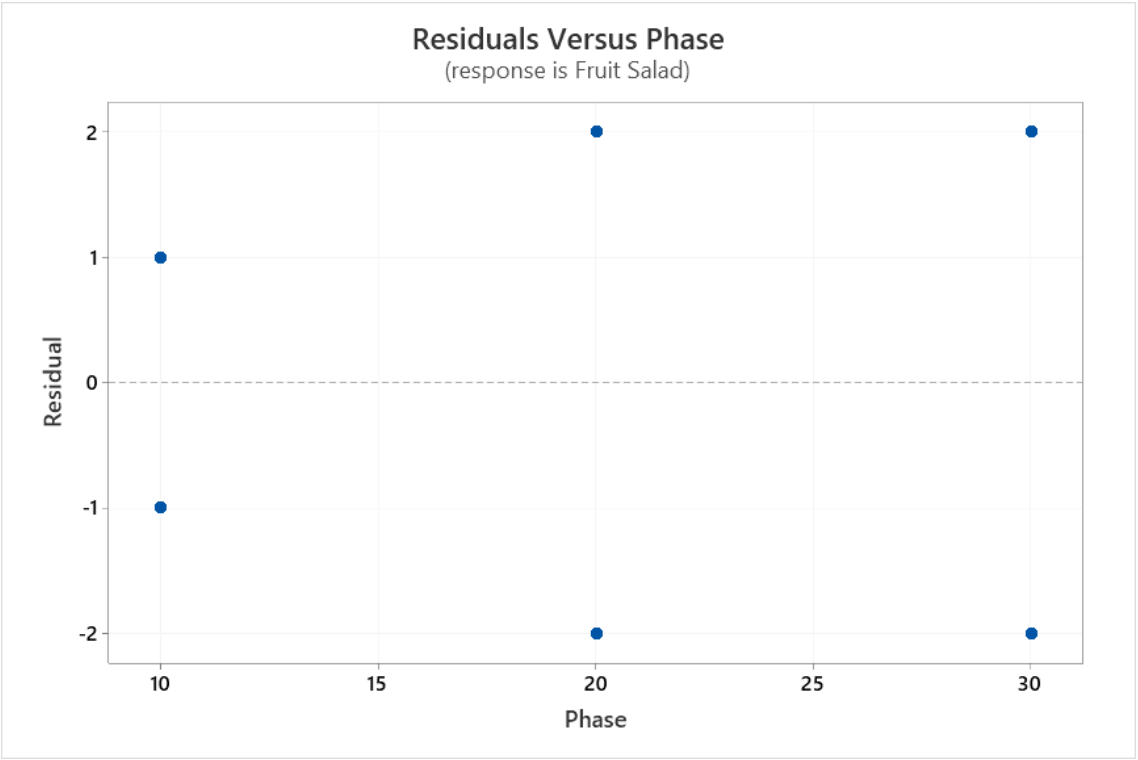

Residuals Versus Phase
(response is Fruit1)
Residual
10
5
0
-5
-10
10
15
20
25
30
Phase

Appendix 2

Fruit Salad

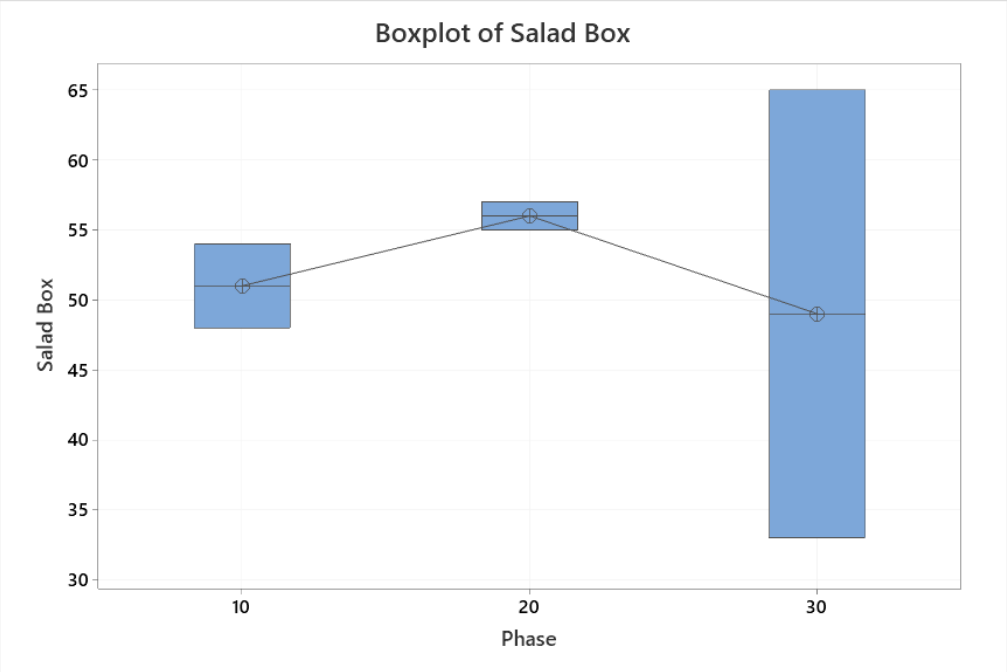


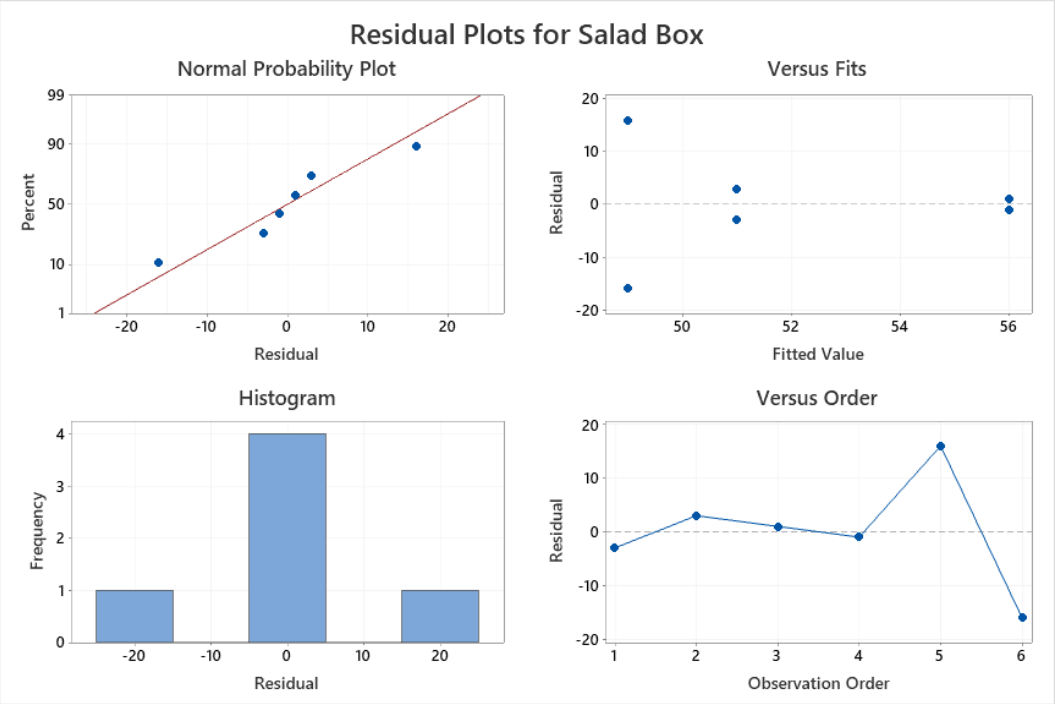


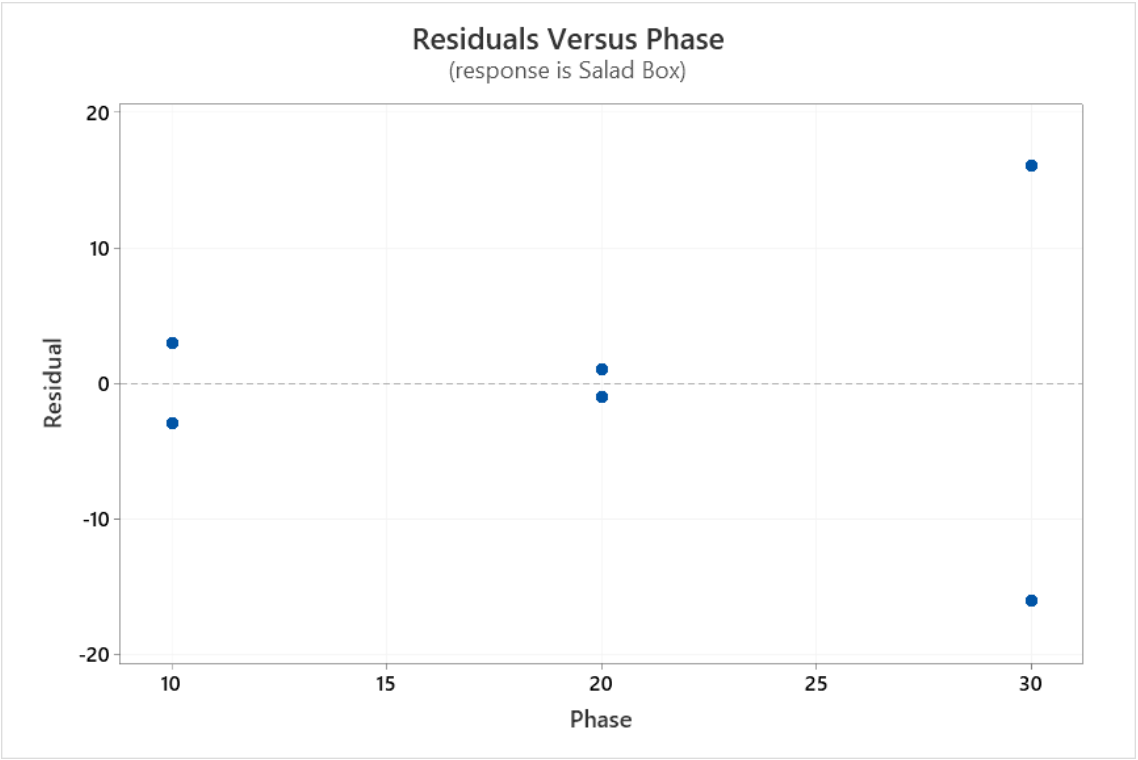

Residuals Versus Phase
(response is Fruit Salad)
Residual
2
1
0
-1
-2
10
15
20
25
30
Phase

Appendix 2

Salad Box

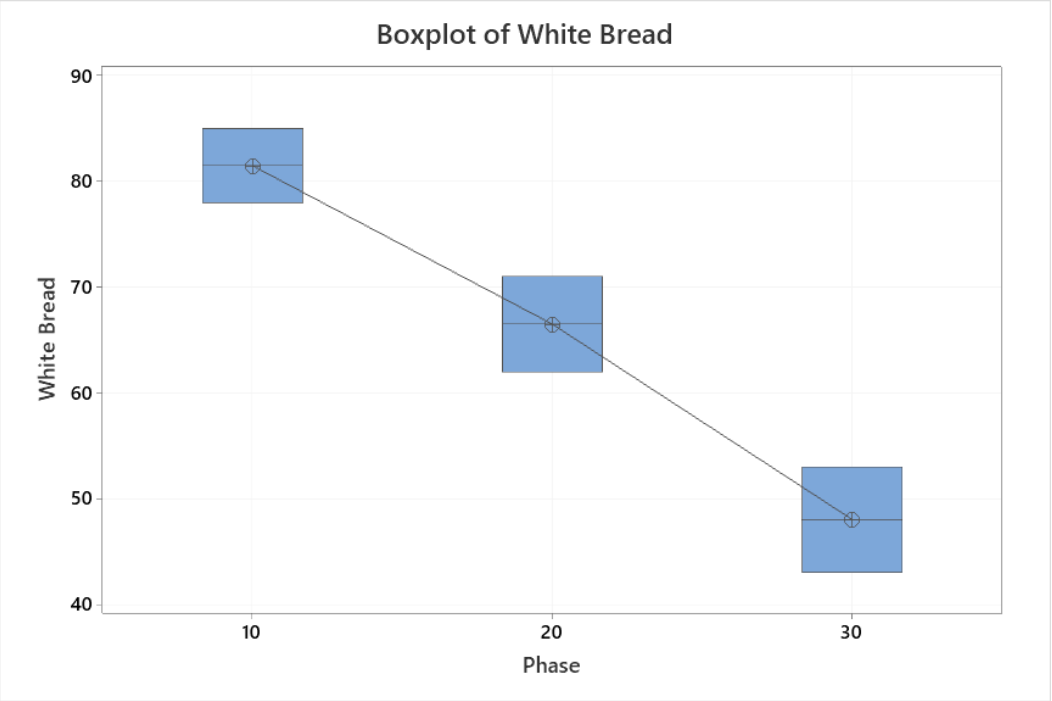


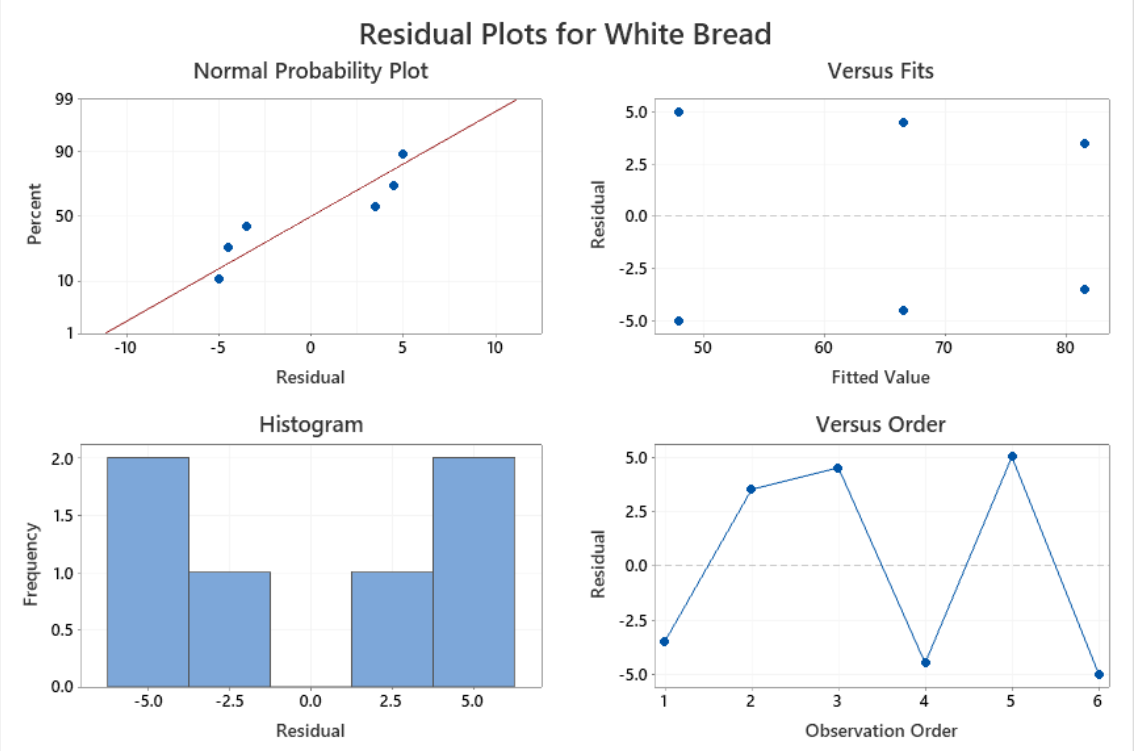


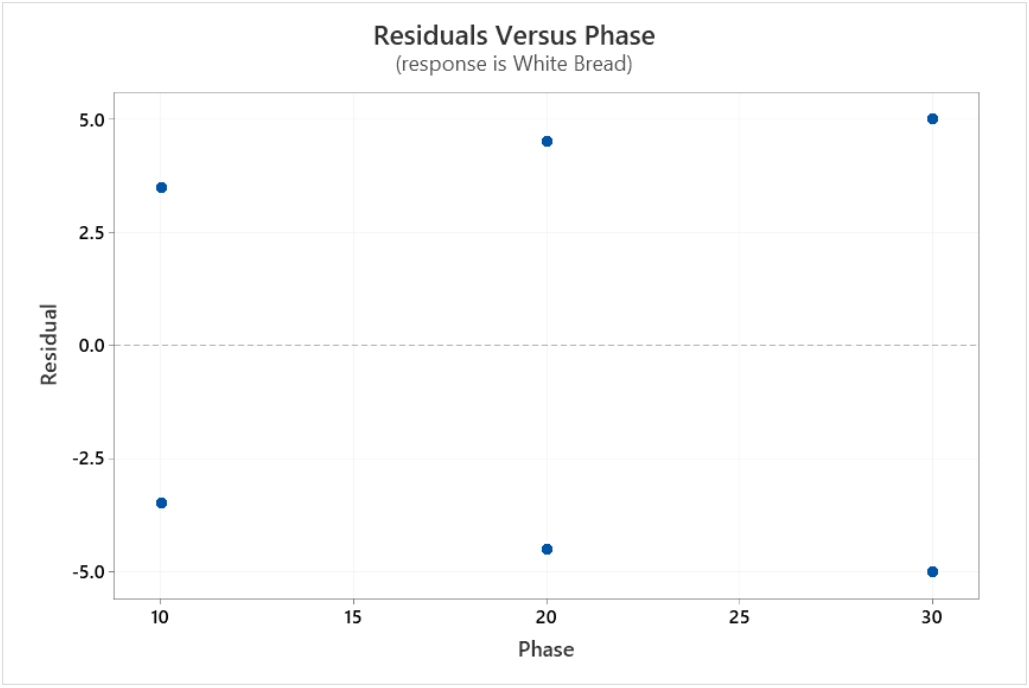

Residuals Versus Phase
(response is Salad Box)
Residual
20
10
0
-10
-20
10
15
20
25
30
Phase

Appendix 2

White Bread

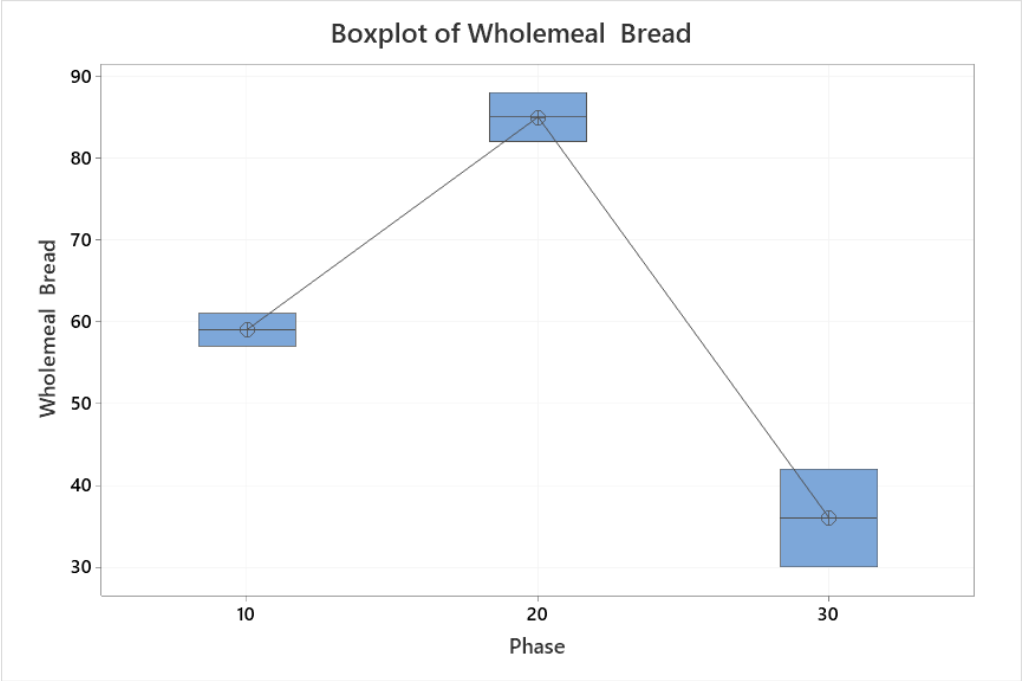


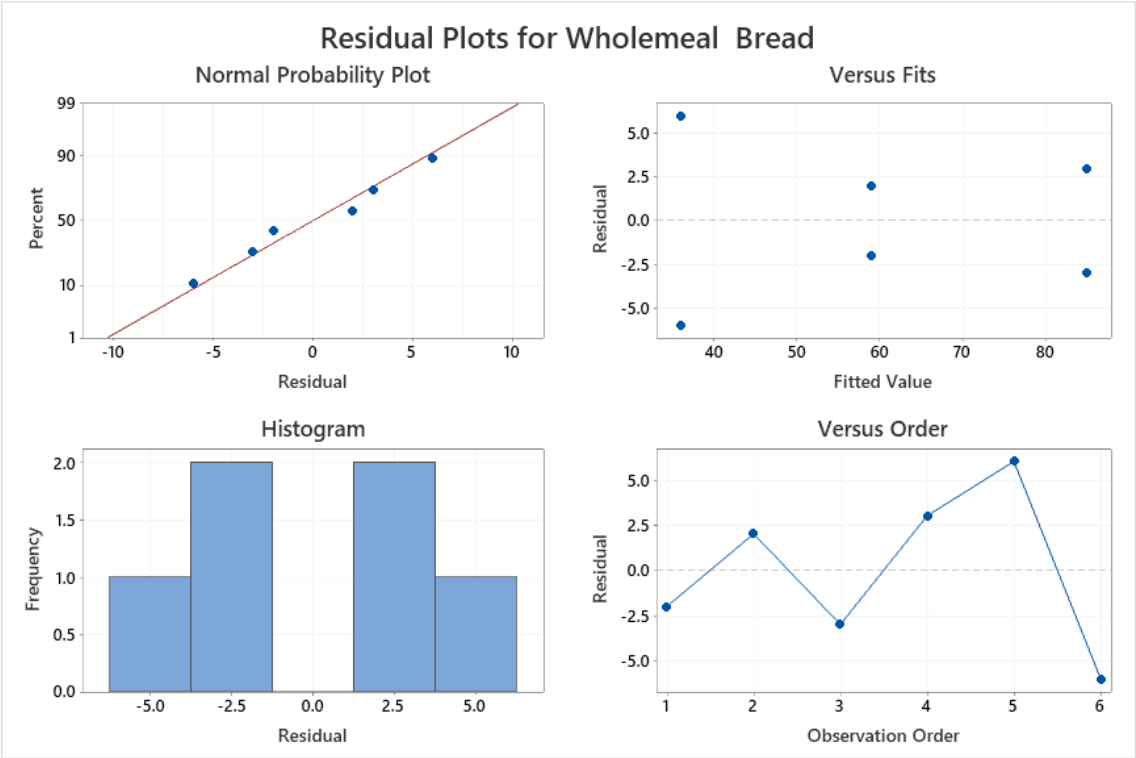


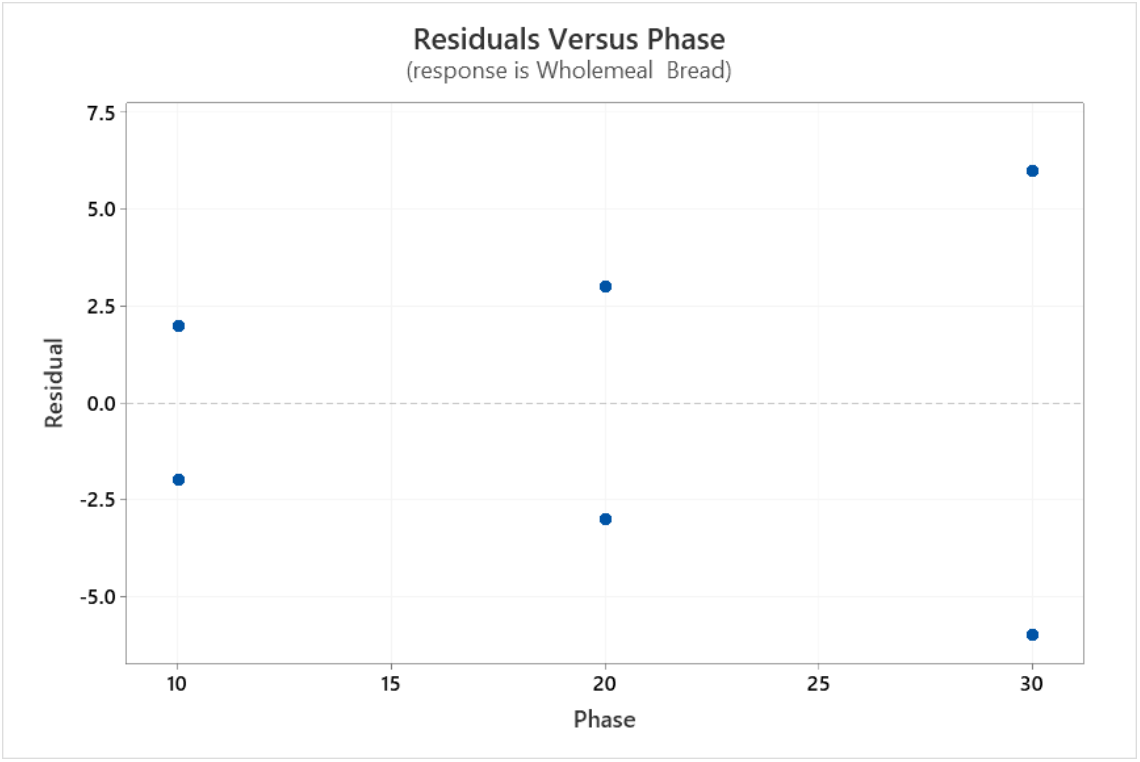

Residuals Versus Phase
(response is White Bread)
Residual
5.0
2.5
0.0
-2.5
-5.0
10
15
20
25
30
Phase

Appendix 2

Wholmeal Bread

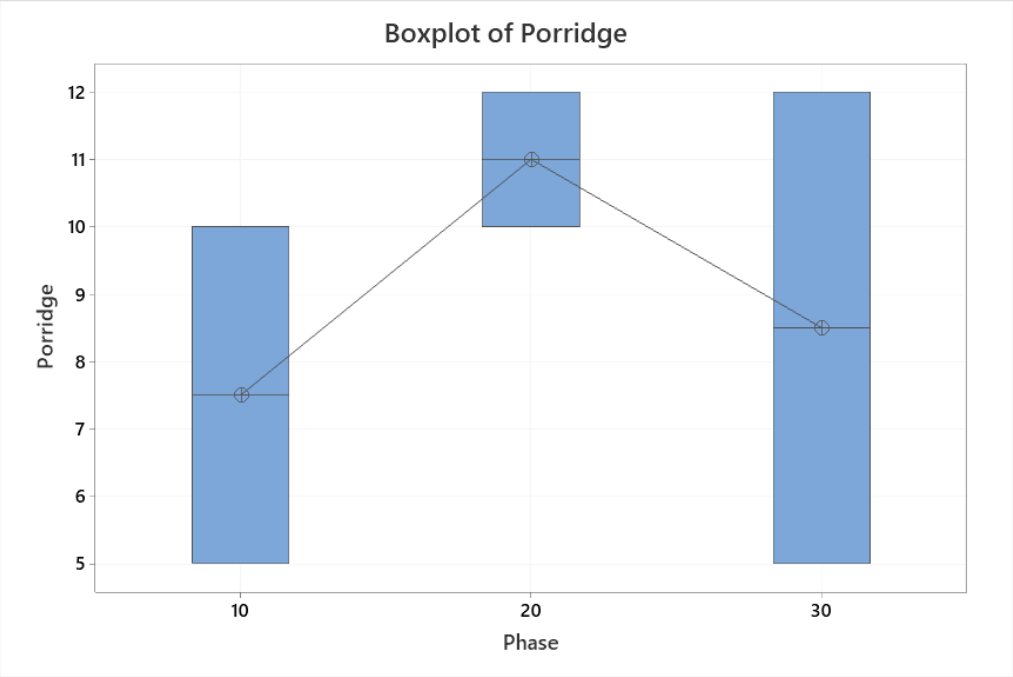


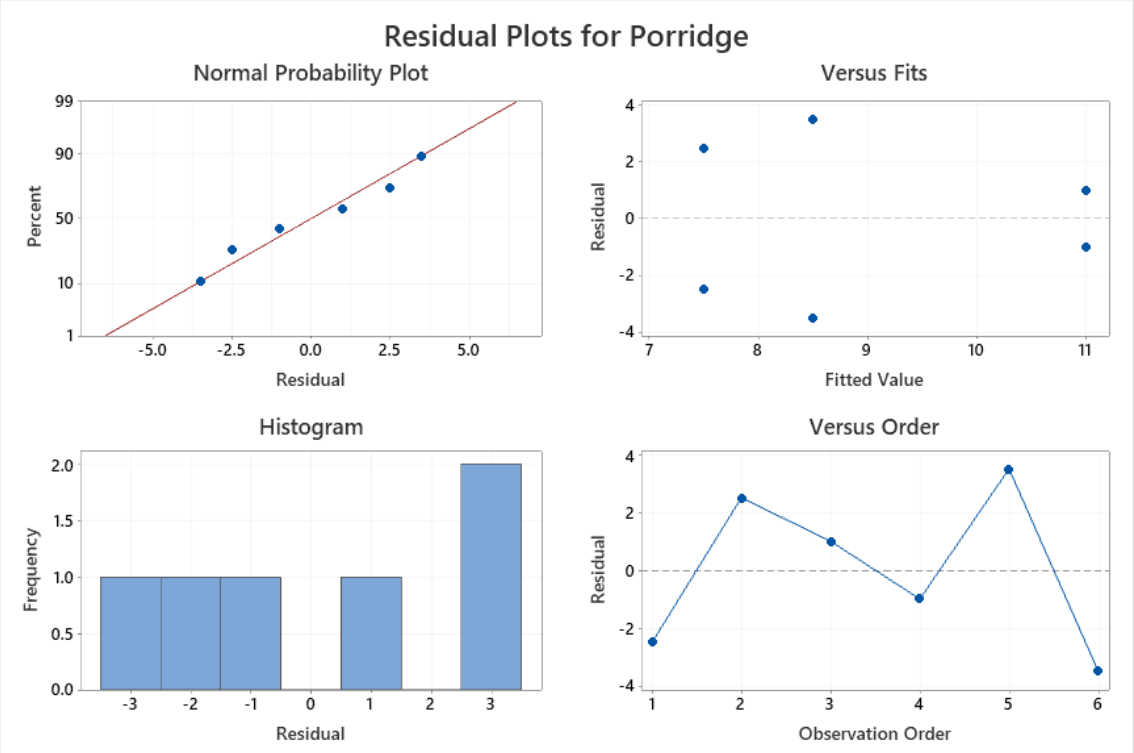


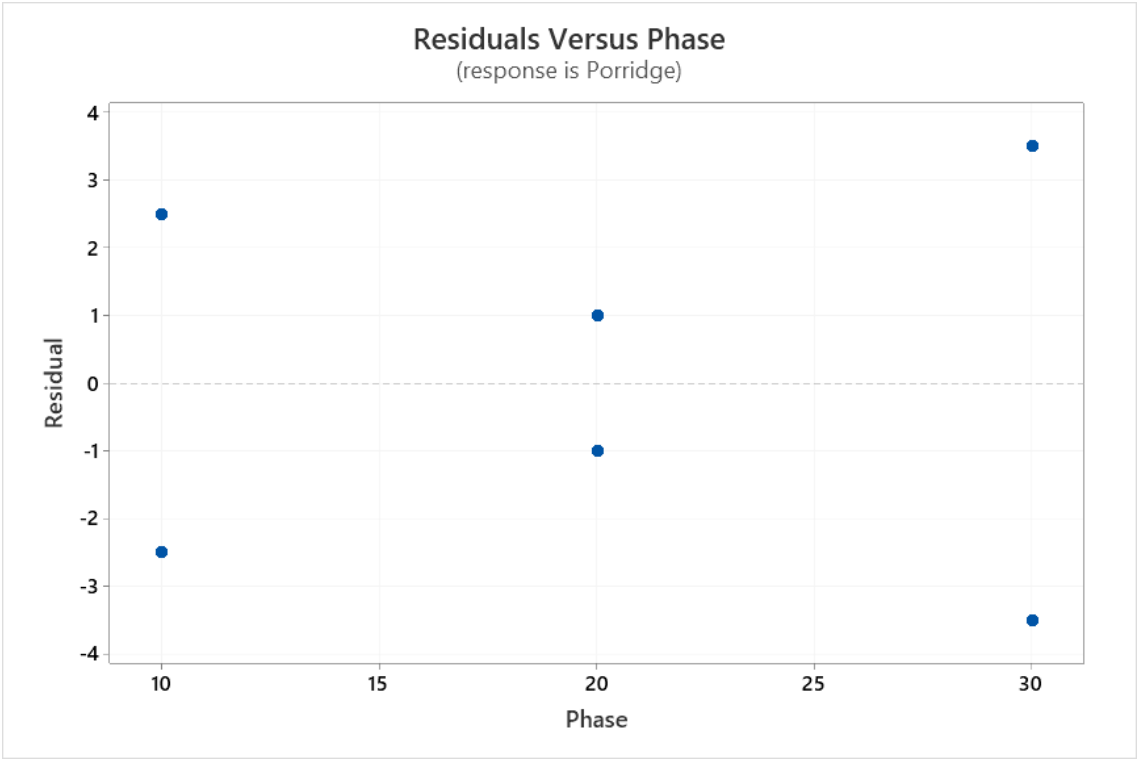

Residuals Versus Phase
(response is Wholemeal Bread)
Residual
7.5
5.0
2.5
0.0
-2.5
-5.0
10
15
20
25
30
Phase

Appendix 2

Porridge

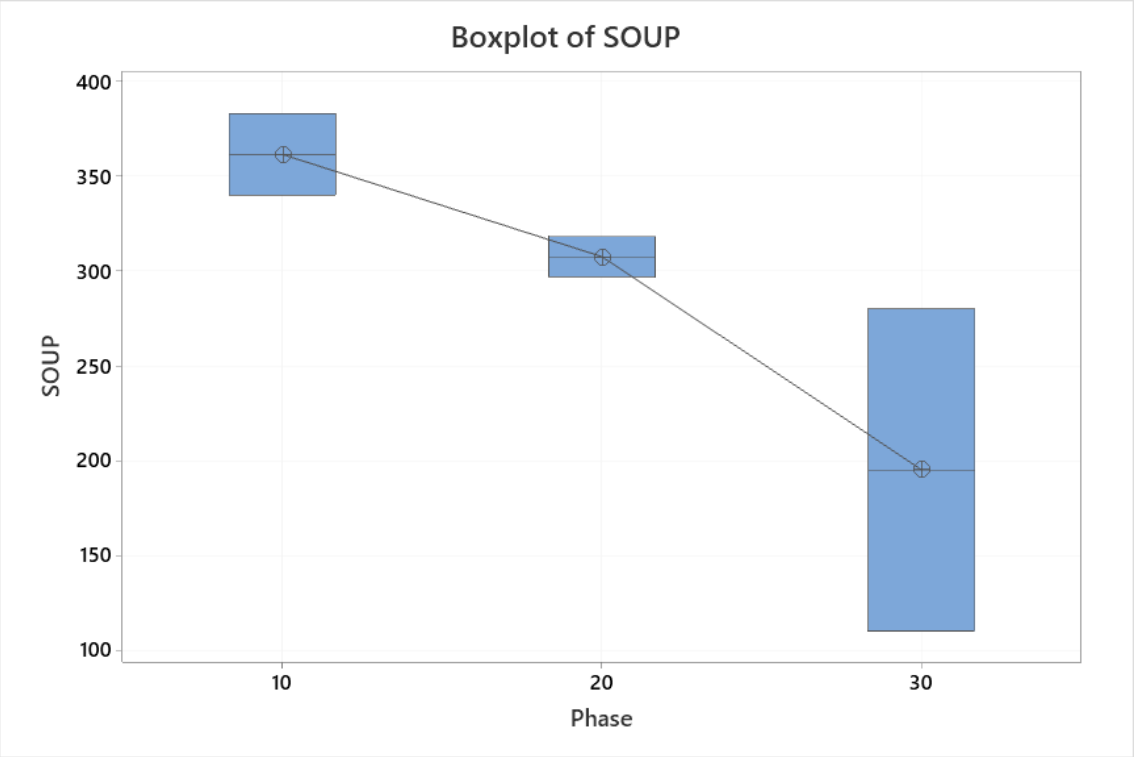


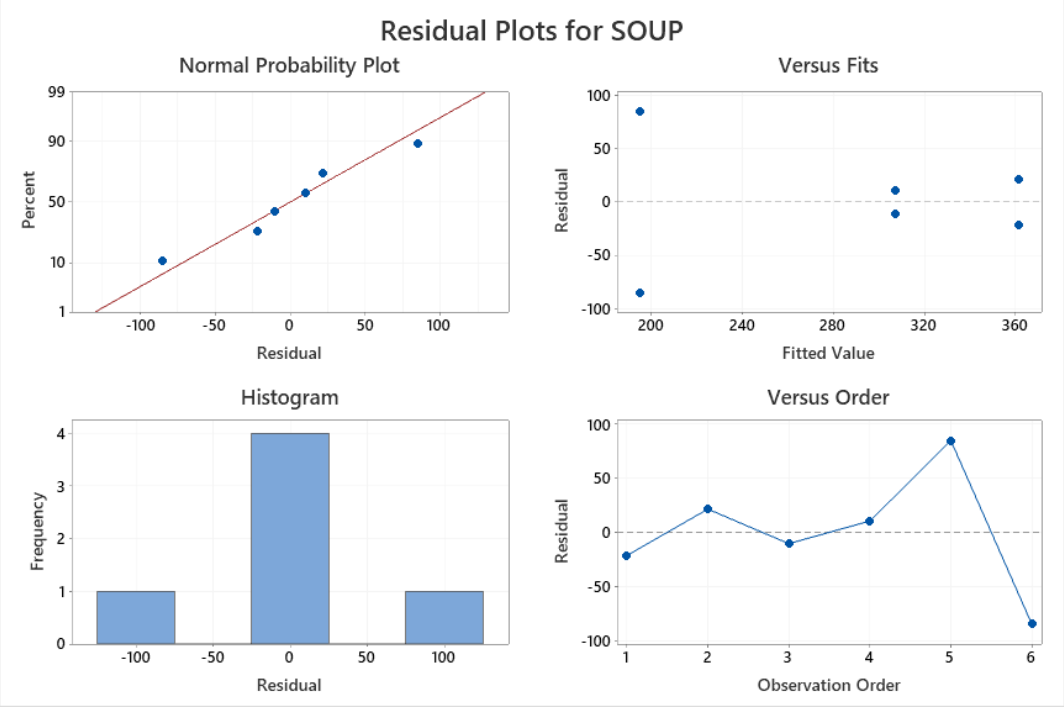


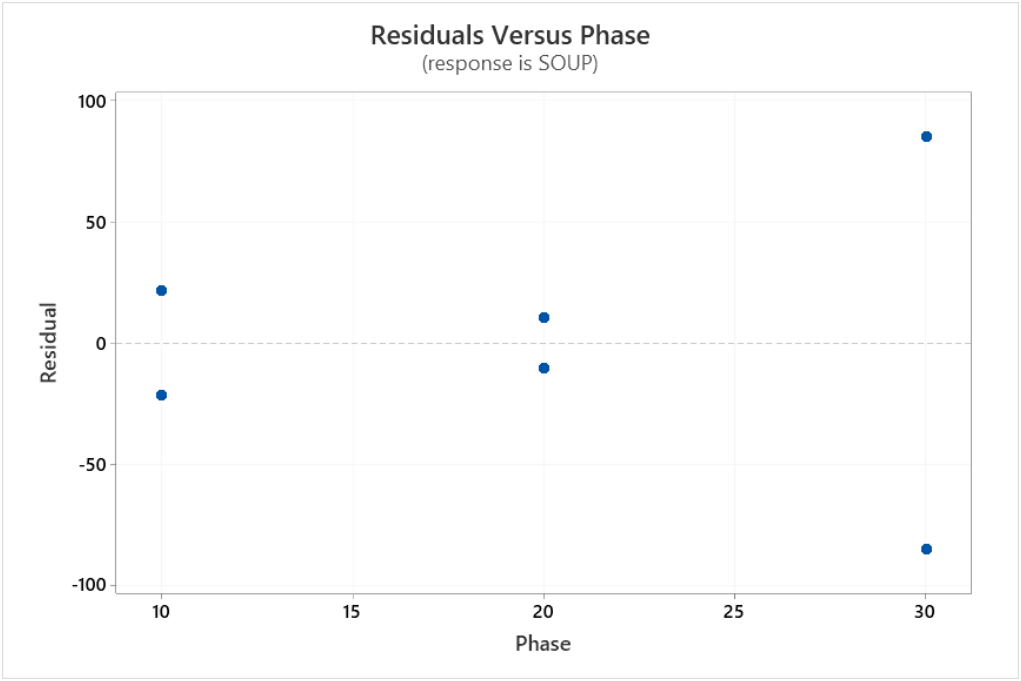

Residuals Versus Phase
(response is Porridge)
Residual
4
3
2
1
0
-1
-2
-3
-4
10
15
20
25
30
Phase

Appendix 2

Soup

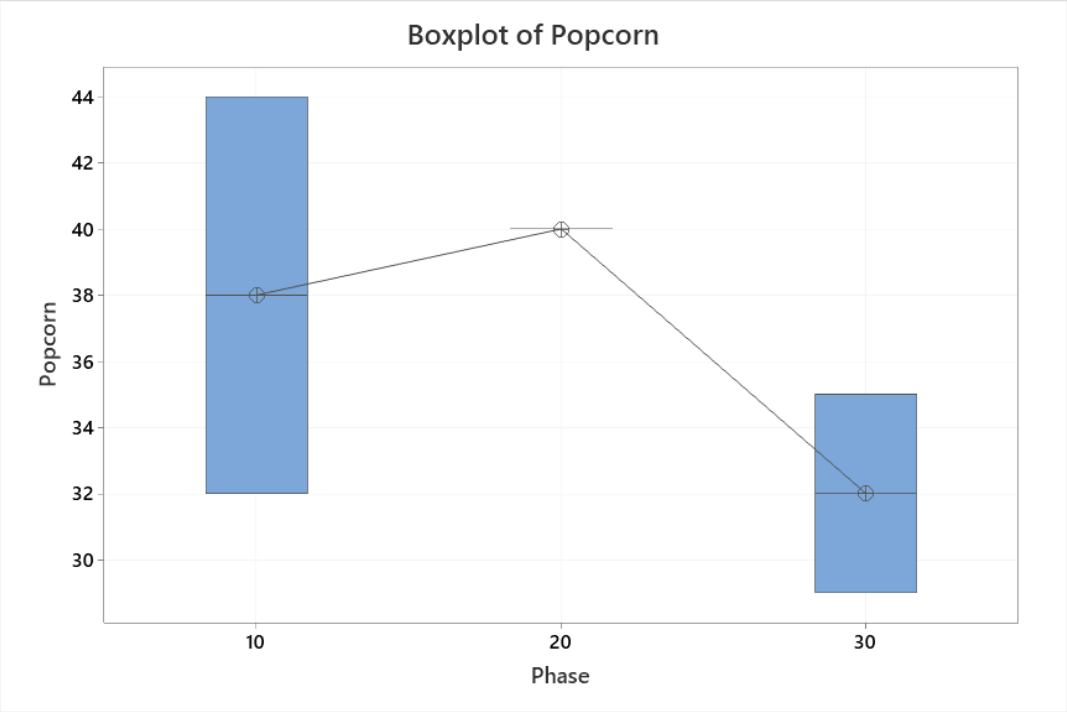


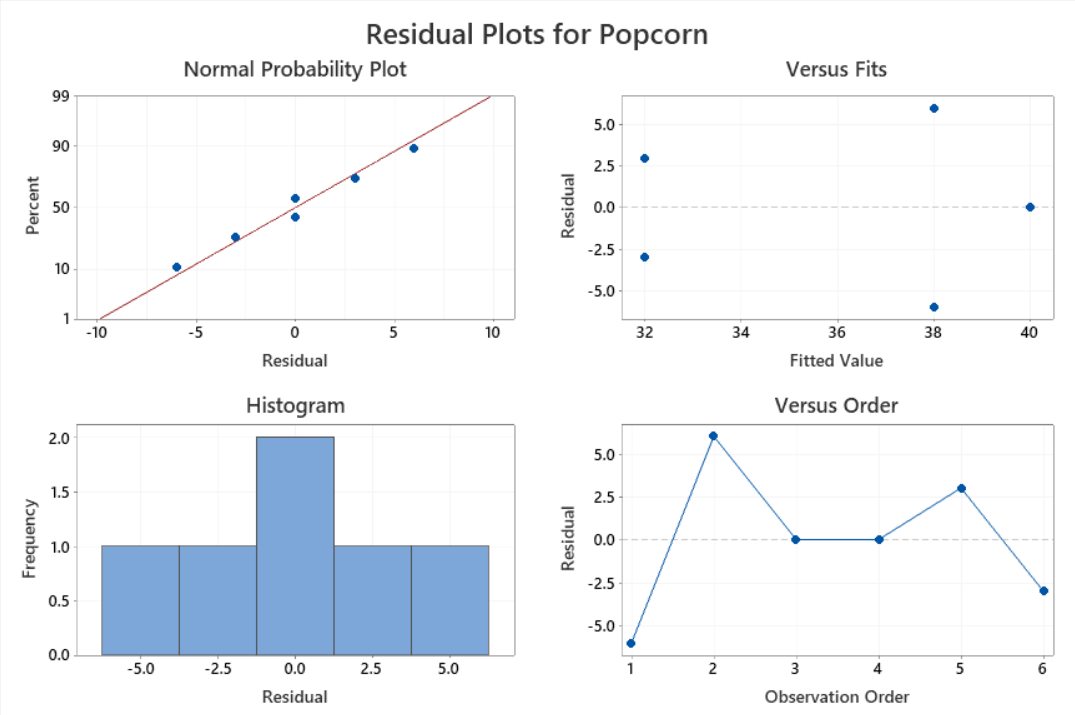


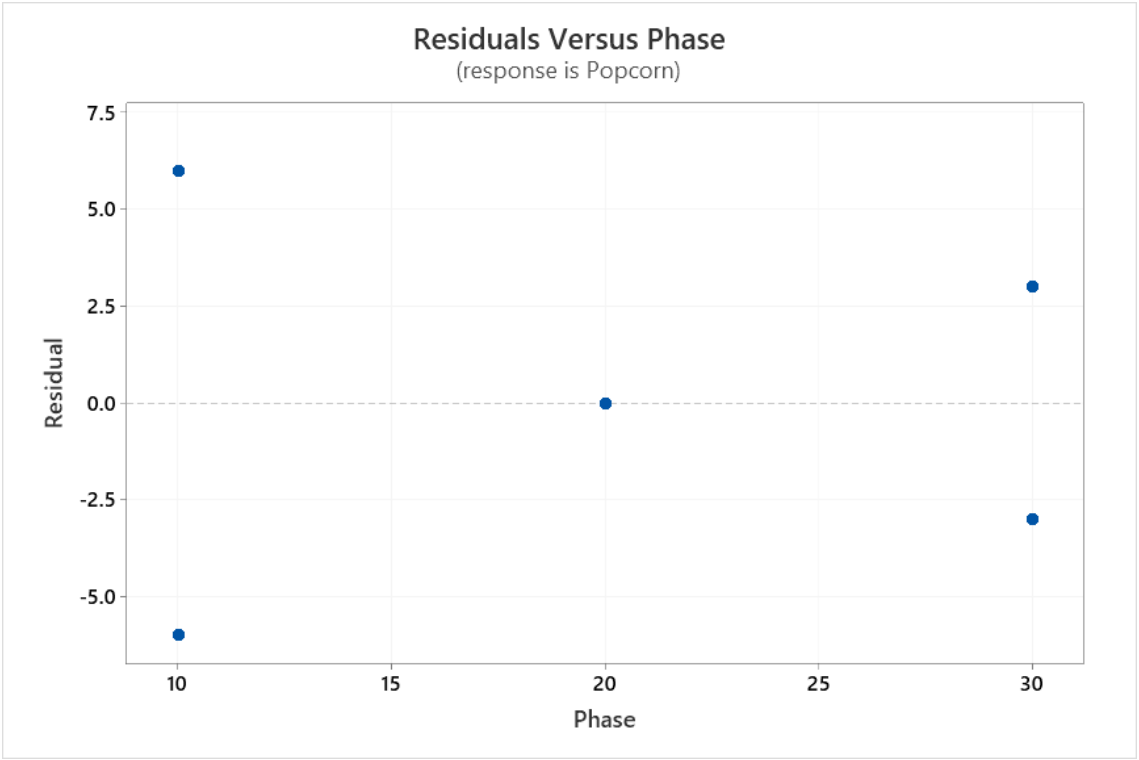

Residuals Versus Phase
(response is SOUP)
Residual
100
50
0
-50
-100
10
15
20
25
30
Phase

Appendix 2

Popcorn

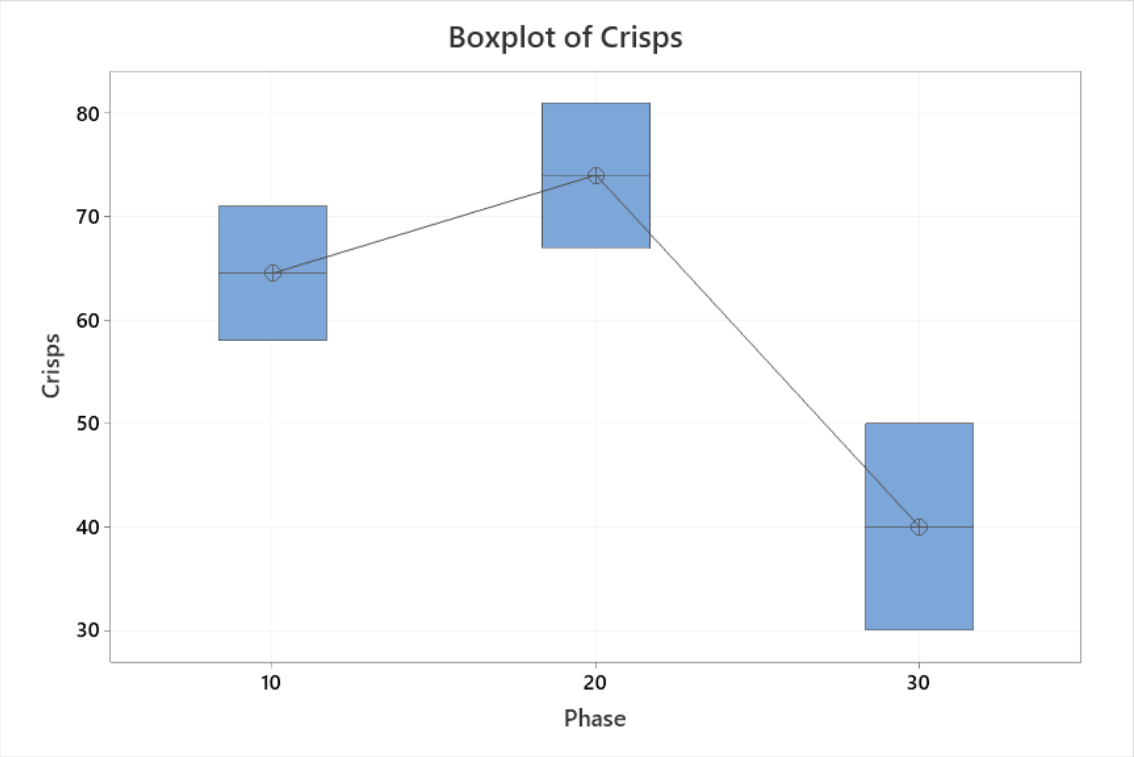


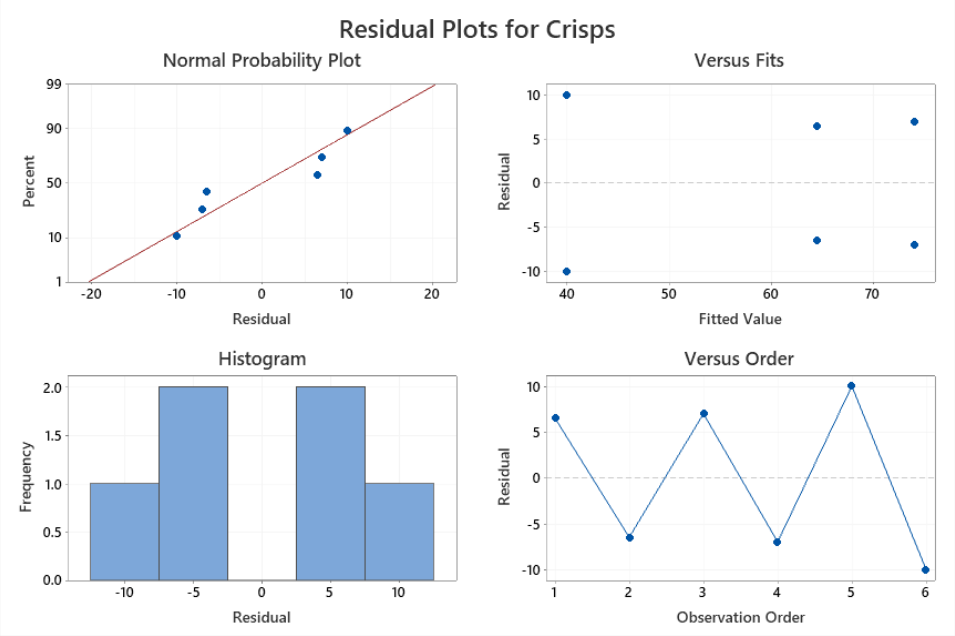


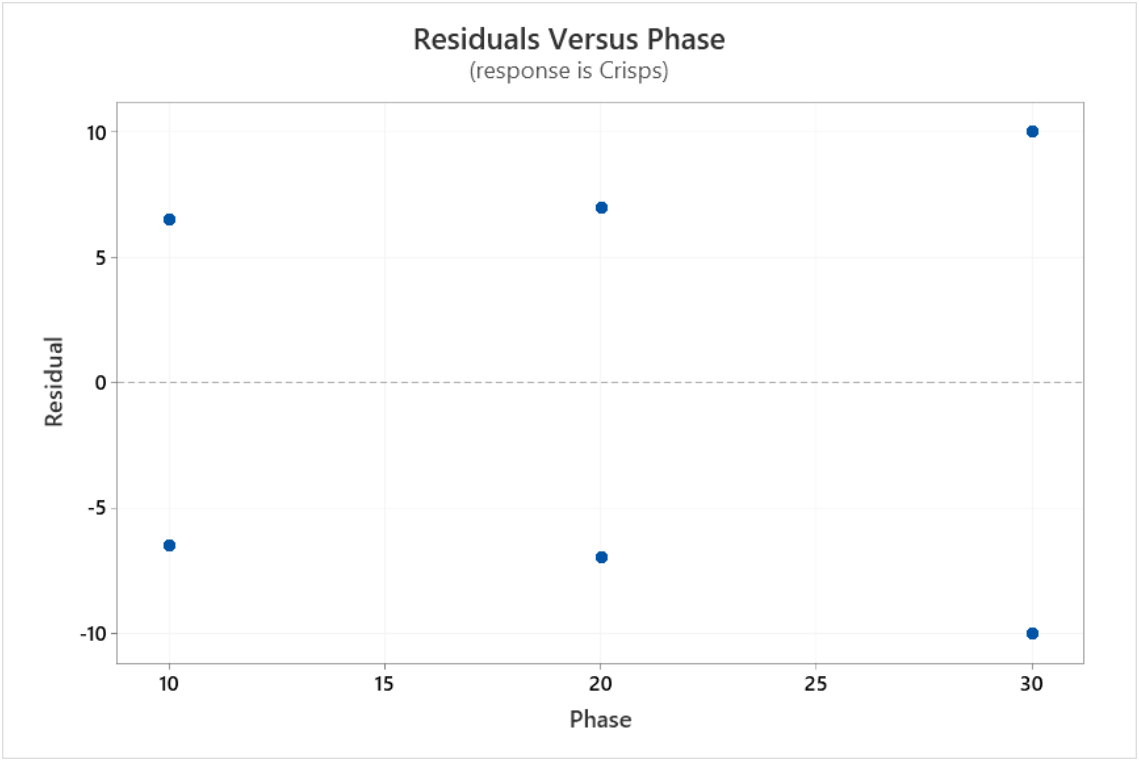

Residuals Versus Phase
(response is Popcorn)
Residual
7.5
5.0
2.5
0.0
-2.5
-5.0
10
15
20
25
30
Phase

Appendix 2

Crisps

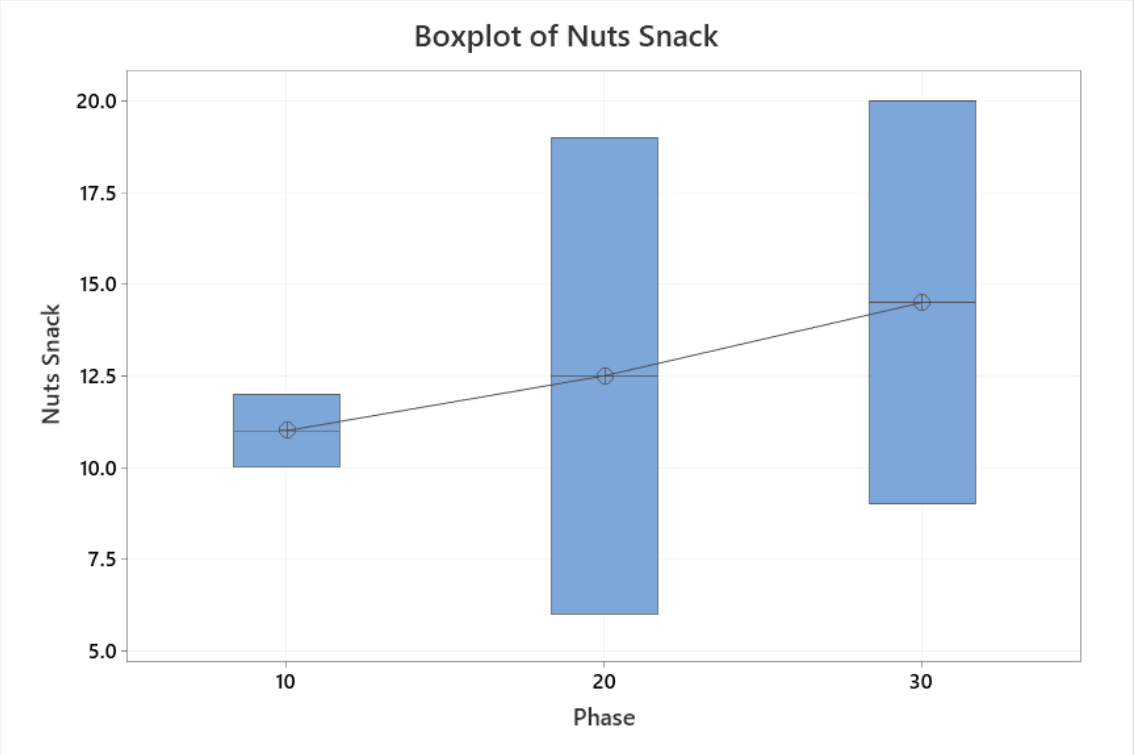


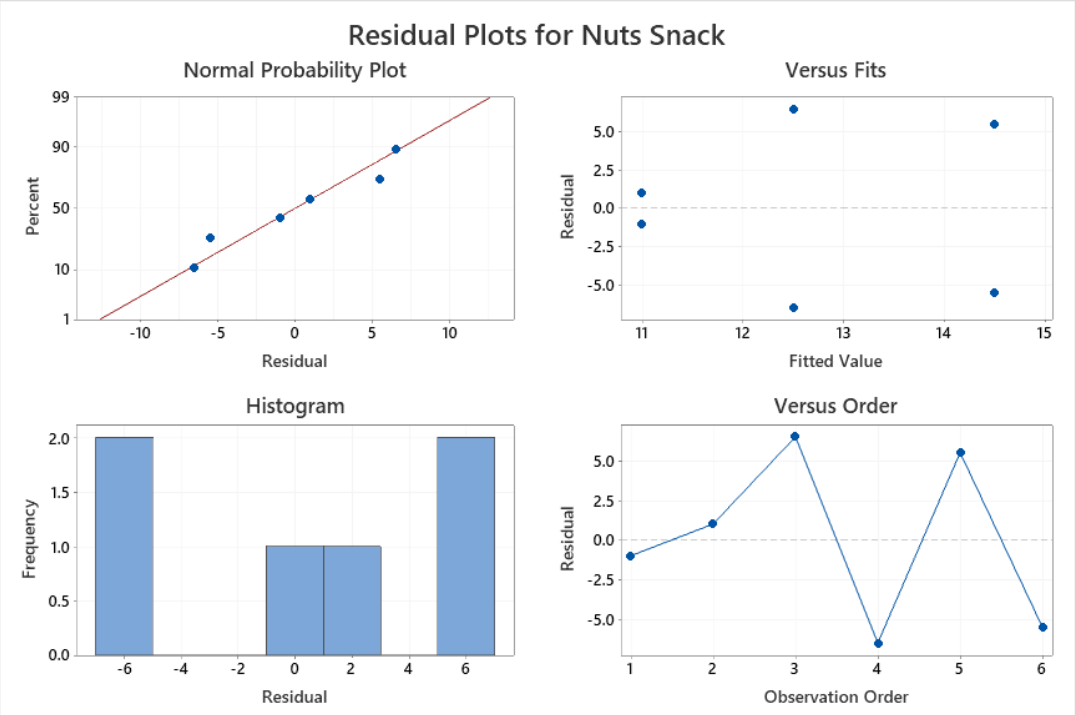


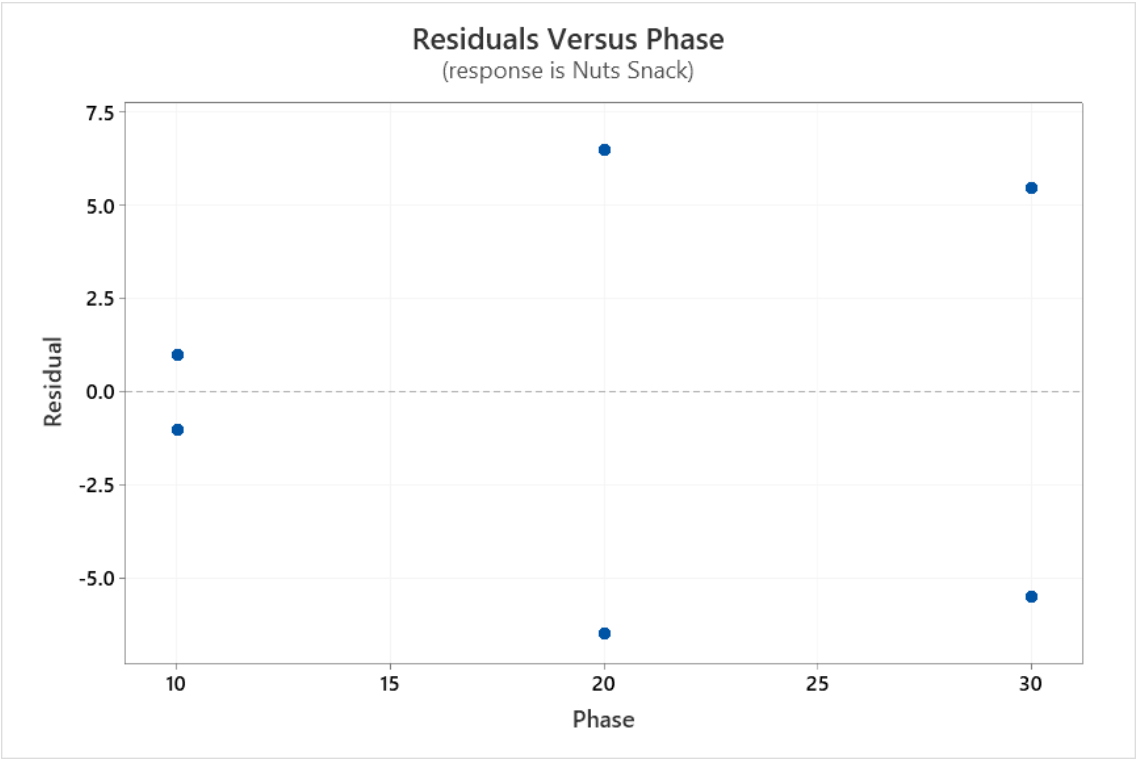

Residuals Versus Phase
(response is Crisps)
Residual
10
5
0
-5
-10
10
15
20
25
30
Phase

Appendix 2

Packet of Nuts

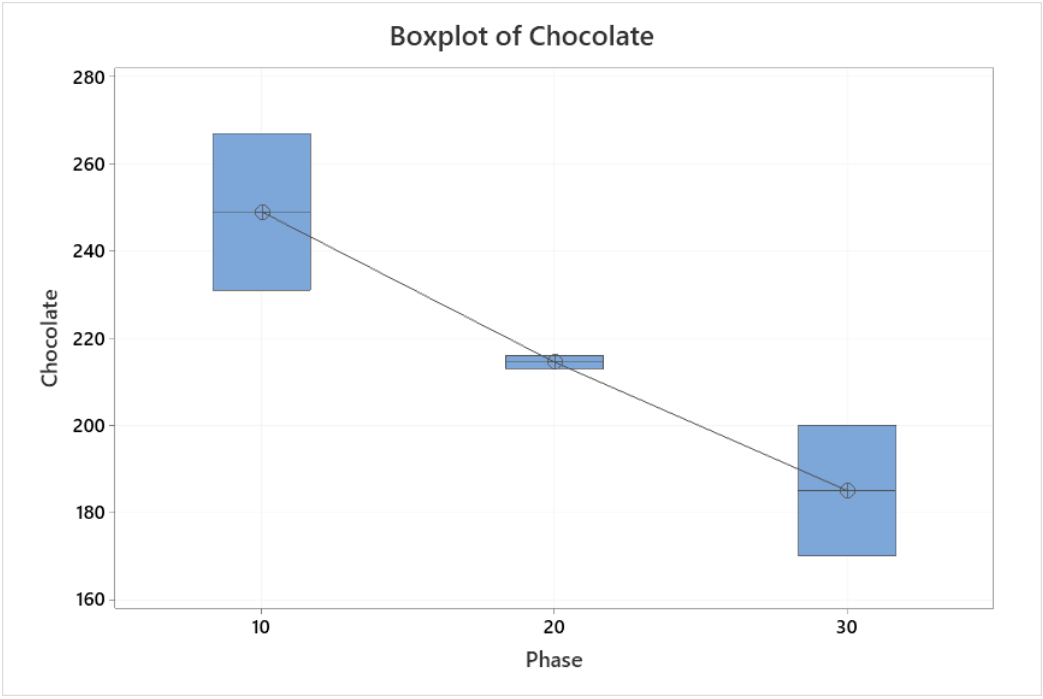


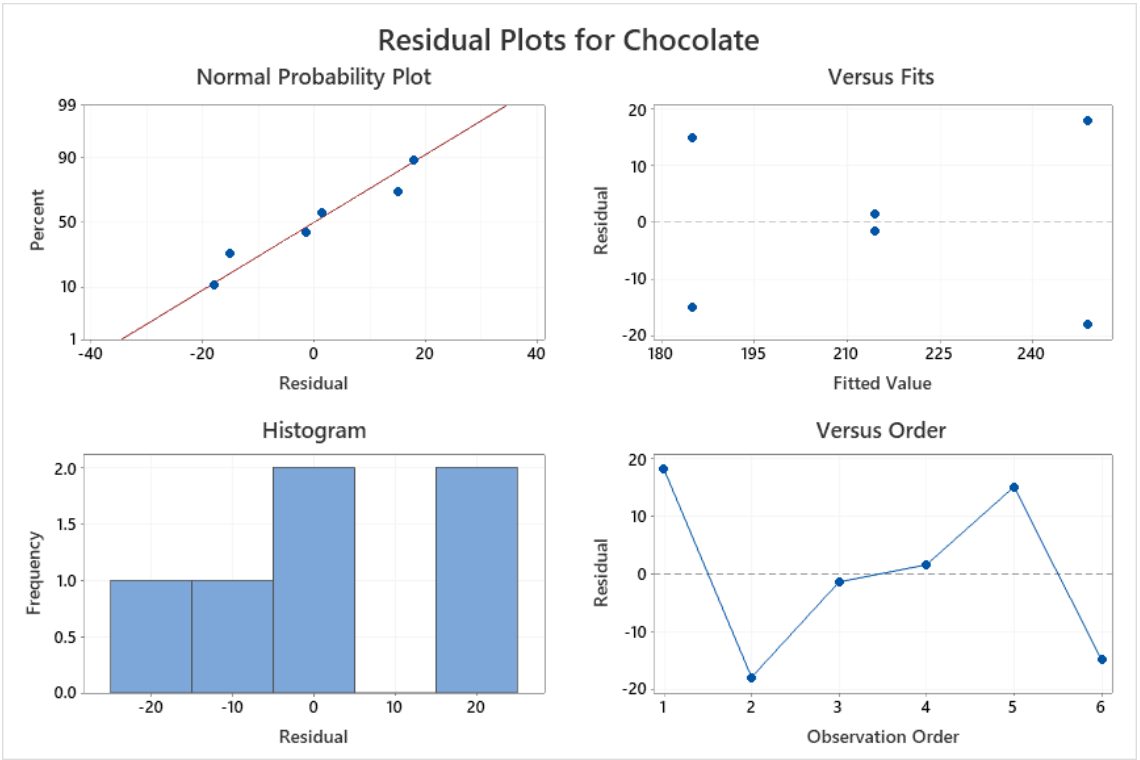


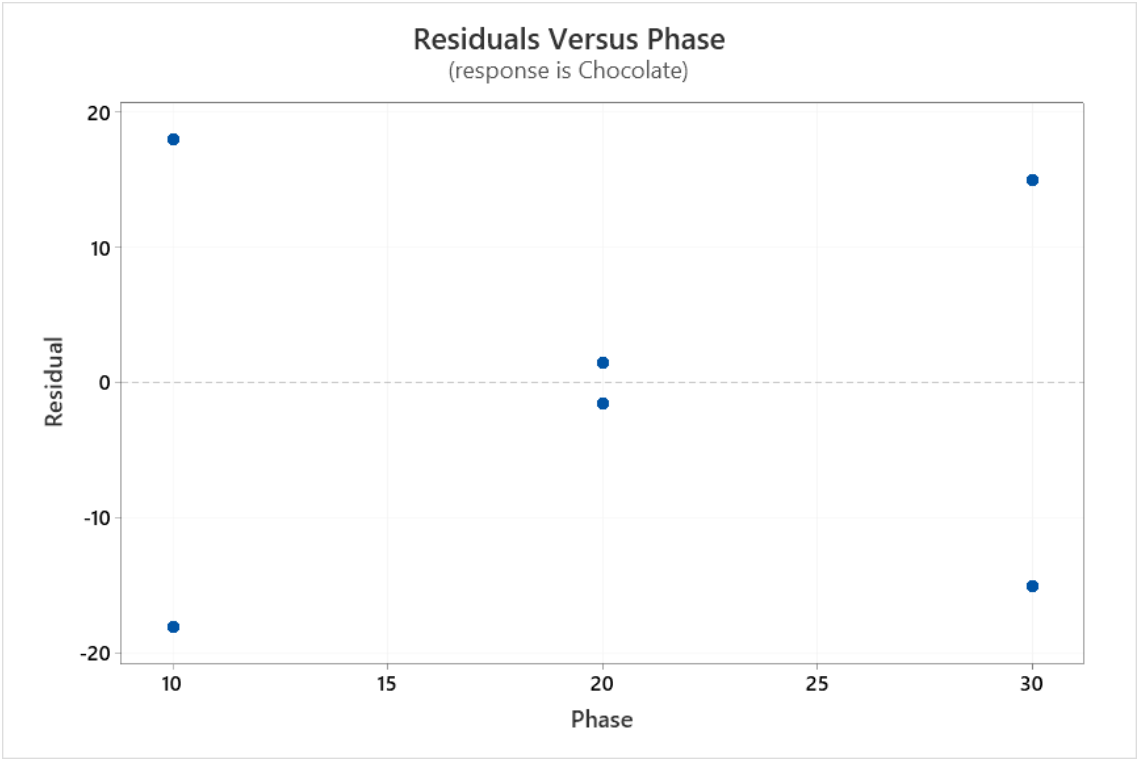

Residuals Versus Phase
(response is Nuts Snack)
Residual
7.5
5.0
2.5
0.0
-2.5
-5.0
10
15
20
25
30
Phase

Appendix 2

Chocolate bar






Residuals Versus Phase
(response is Chocolate)
Residual
20
10
0
-10
-20
10
15
20
25
30
Phase

Appendix 3

One way ANOVA for each target food

Appendix 3

One way ANOVA Fruit versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Phase	2	1716.3	858.2	6.09	0.088
Error	3	422.5	140.8		
Total	5	2138.8			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
11.8673	80.25%	67.08%	20.98%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	65.50	13.44	(38.79, 92.21)
Intervention	2	103.0	0.0	(76.3, 129.7)
Post	2	69.0	15.6	(42.3, 95.7)

Pooled StDev = 11.8673

Appendix 3

One way ANOVA Fruit Salad versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	33.33	16.667	2.78	0.208
Error	3	18.00	6.000		
Total	5	51.33			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.44949	64.94%	41.56%	0.00%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	7.00	1.41	(1.49, 12.51)
Intervention	2	12.00	2.83	(6.49, 17.51)
Post	2	12.00	2.83	(6.49, 17.51)

Pooled StDev = 2.44949

Appendix 3

One way ANOVA Fruit Salad versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	52.00	26.00	0.15	0.869
Error	3	532.00	177.33		
Total	5	584.00			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
13.3167	8.90%	0.00%	0.00%

Means

Phase	N	Mean	StDev	95% CI
Pre Intervention	2	51.00	4.24	(21.03, 80.97)
Intervention	2	56.00	1.41	(26.03, 85.97)
Post	2	49.0	22.6	(19.0, 79.0)

Pooled StDev = 13.3167

Appendix 3

One way ANOVA Wholemeal versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	2404.00	1202.00	36.80	**0.008**
Error	3	98.00	32.67		
Total	5	2502.00			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
5.71548	96.08%	93.47%	84.33%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	59.00	2.83	(46.14, 71.86)
Intervention	2	85.00	4.24	(72.14, 97.86)
Post	2	36.00	8.49	(23.14, 48.86)

Pooled StDev = 5.71548

Grouping Information Using the Tukey Method and 95% Confidence

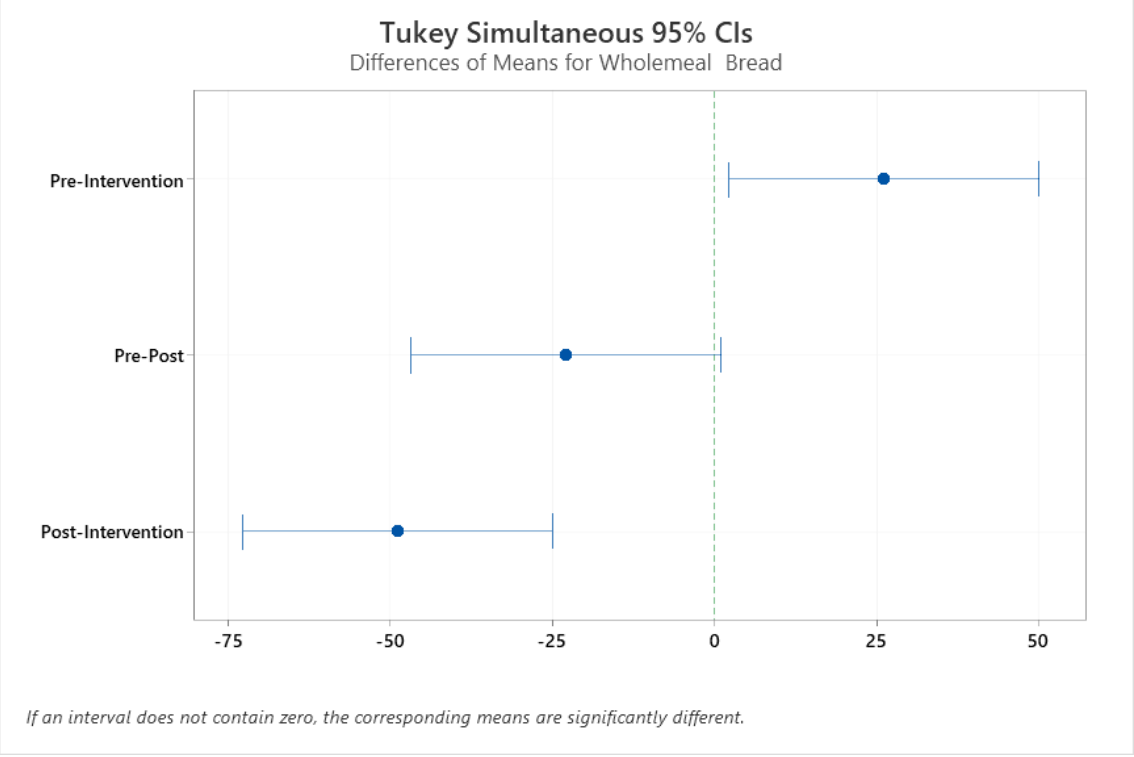
Phase	N	Mean	Grouping	
Pre	2	59.00		B
Intervention	2	85.00	A	
Post	2	36.00		B

Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference of Levels	Difference of Means	SE of Difference	95% CI	T-Value	Adjusted P-Value
Pre / Intervention	26.00	5.72	(2.12, 49.88)	4.55	**0.040**
Pre / Post	-23.00	5.72	(-46.88, 0.88)	-4.02	0.055
Intervention / Post	-49.00	5.72	(-72.88, -25.12)	-8.57	**0.007**

Individual confidence level = 97.50%



Appendix 3

One way ANOVA White bread versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	1126.3	563.17	14.69	**0.028**
Error	3	115.0	38.33		
Total	5	1241.3			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
6.19139	90.74%	84.56%	62.94%

Means

Phase	N	Mean	St Dev	95% CI
Pre	2	81.50	4.95	(67.57, 95.43)
Intervention	2	66.50	6.36	(52.57, 80.43)
Post	2	48.00	7.07	(34.07, 61.93)

Pooled St Dev = 6.19139

Grouping Information Using the Tukey Method and 95% Confidence

Phase	N	Mean	Grouping

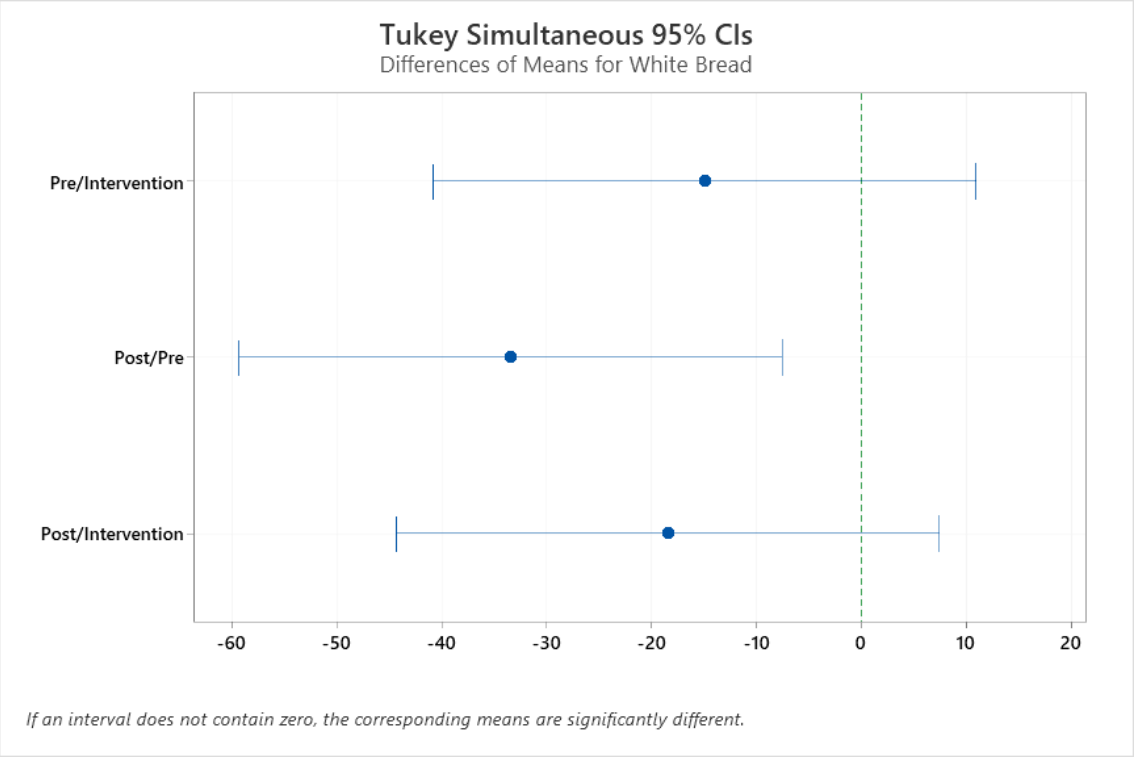
Pre	2	81.50	A	
Intervention	2	66.50	A	B
Post	2	48.00		B

Means that do not share a letter are significantly different.

Tukey Simultaneous Tests for Differences of Means

Difference of Levels	Difference of Means	SE of Difference	95% CI	T-Value	Adjusted P-Value
Pre / Intervention	-15.00	6.19	(-40.87, 10.87)	-2.42	0.179
Post / Pre Intervention	-33.50	6.19	(-59.37, -7.63)	-5.41	**0.025**
Post / Intervention	-18.50	6.19	(-44.37, 7.37)	-2.99	0.114

Individual confidence level = 97.50%



Appendix 3

One way ANOVA Porridge versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	13.00	6.500	0.50	**0.650**
Error	3	39.00	13.000		
Total	5	52.00			

Model Summary

S	R-sq	R-sq (adj)	R-sq (pred)
3.60555	25.00%	0.00%	0.00%

Means

Phase	N	Mean	St Dev	95% CI
Pre	2	7.50	3.54	(-0.61, 15.61)
Intervention	2	11.00	1.41	(2.89, 19.11)
Post	2	8.50	4.95	(0.39, 16.61)

Pooled St Dev = 3.60555

Appendix 3

One way ANOVA Soup versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	28863	14432	2.78	**0.208**
Error	3	15595	5198		
Total	5	44458			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
72.0995	64.92%	41.54%	0.00%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	361.5	30.4	(199.3, 523.7)
Intervention	2	307.5	14.8	(145.3, 469.7)
Post	2	195.0	120.2	(32.8, 357.2)

Pooled St Dev = 72.0995

Appendix 3

One way ANOVA Popcorn versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	69.33	34.67	1.16	0.425
Error	3	90.00	30.00		
Total	5	159.33			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
5.47723	43.51%	5.86%	0.00%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	38.00	8.49	(25.67, 50.33)
Intervention	2	40.00	0.00	(27.67, 52.33)
Post	2	32.00	4.24	(19.67, 44.33)

Pooled St Dev = 5.47723

Appendix 3

One way ANOVA Crisps versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	1231.0	615.5	4.83	0.115
Error	3	382.5	127.5		
Total	5	1613.5			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
11.2916	76.29%	60.49%	5.18%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	64.50	9.19	(39.09, 89.91)
Intervention	2	74.00	9.90	(48.59, 99.41)
Post	2	40.0	14.1	(14.6, 65.4)

Pooled St Dev = 11.2916

Appendix 3

One way ANOVA Nuts Snack versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	12.33	6.167	0.13	0.886
Error	3	147.00	49.000		
Total	5	159.33			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
7	7.74%	0.00%	0.00%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	11.00	1.41	(-4.75, 26.75)
Intervention	2	12.50	9.19	(-3.25, 28.25)
Post	2	14.50	7.78	(-1.25, 30.25)

Pooled St Dev = 7

Appendix 3

One way ANOVA Chocolate Bar versus Phase (Pre/Intervention/Post)

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Pre/ Intervention/ Post	3	10, 20, 30

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Pre/ Intervention/ Post	2	4104	2052.2	5.58	0.097
Error	3	1102	367.5		
Total	5	5207			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
19.1703	78.83%	64.71%	15.30%

Means

Phase	N	Mean	StDev	95% CI
Pre	2	249.0	25.5	(205.9, 292.1)
Intervention	2	214.50	2.12	(171.36, 257.64)
Post	2	185.0	21.2	(141.9, 228.1)

Pooled St Dev = 19.1703

Appendix 4

Pictures of nudges strategies during Intervention phase

Appendices 4

Counter of Fruit display in the pre intervention phase

Counter of Fruit display in the intervention phase. Fruit in the eye level with the icon" Good for you" beside the fruit bowl

Appendices 4

Fruit displayed in a different counter where students queued to get the meals.

Appendices 4

A3 poster displayed in the Main entrance of the restaurant providing disclosures to increase the sales of the target food.