

EVALUATION OF SALT CONTENT IN MEALS AVAILABLE AT
UNIVERSITI SAINS MALAYSIA (USM), HEALTH CAMPUS
CAFETERIA

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EVALUATION OF SALT CONTENT IN MEALS AVAILABLE AT
UNIVERSITI SAINS MALAYSIA (USM), HEALTH CAMPUS
CAFETERIA

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the Degree of Bachelor in Nutrition with Honours

January 2025

CERTIFICATE

This is to certify that the dissertation entitled “EVALUATION OF SALT CONTENT IN MEALS AVAILABLE AT UNIVERSITI SAINS MALAYSIA (USM), HEALTH CAMPUS CAFETERIA” is the bona fide record of research work done by Ms NURUL HUDA BINTI JAAFAR, MATRIC NUMBER 159954 during the period from October 2024 to January 2025 under my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the Degree of Bachelor in Nutrition with Honours.

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.



.....
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Date: 12/1/2025

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LIST OF SYMBOLS

\geq	Greater than or equal to
$<$	Less than
$>$	Greater than
$^{\circ}\text{C}$	Degree Celsius
%	Percentage
N	Normality of solution
g	Gram
mg	Miligram
L	Litre
mL	Mililitre
NaCl	Sodium chloride / salt
Na	Sodium
AgCl	Silver chloride
AgNO ₃	Silver nitrate
KSCN	Potassium thiocyanate

LIST OF ABBREVIATIONS

WHO	World Health Organization
IS 3507	Indian Standard 3507
USDA	United States Department of Agriculture
RNI	Recommended Nutrient Intake
CVD	Cardiovascular disease
NCD	Non-communicable disease

**PENILAIAN KANDUNGAN GARAM DALAM MAKANAN YANG
TERDAPAT DI KAFETERIA KAMPUS KESIHATAN, UNIVERSITI
SAINS MALAYSIA (USM)**

ABSTRAK

Makanan yang dijual di kafeteria kampus merupakan makanan utama untuk pelajar, kakitangan dan pensyarah universiti, terutamanya pada waktu makan tengah hari. Kebanyakan orang cenderung untuk makan tengah hari di kampus semasa waktu rehat untuk menjimatkan masa dan tenaga berbanding makan di luar kampus. Penambahan garam dan sos kepada makanan merupakan amalan lazim rakyat Malaysia dan menjadi penyumbang utama kepada pengambilan natrium. Walaupun natrium berperanan terhadap fungsi saraf dan otot, pengambilan natrium yang berlebihan boleh mendatangkan kesan yang memudaratkan. Kajian ini bertujuan untuk menganalisis kandungan garam dalam makanan yang terdapat di kafeteria, dan dibahagikan kepada dua kategori iaitu makanan utama dan makanan ringan bagi menggalakkan pengguna membuat pilihan makanan yang bijak. Makanan utama (0.975 g/100 g) didapati mempunyai purata kandungan garam yang lebih tinggi berbanding makanan ringan (0.562 g/100 g). Makanan dikategorikan kepada tiga tahap natrium iaitu rendah (<120 mg/100 g), sederhana (120-599 mg/100 g) dan tinggi (>600 mg/100 g). 60% daripada item makanan terpilih dalam kajian ini jatuh dalam paras natrium sederhana. Dalam kategori paras natrium rendah, makanan ringan merupakan penyumbang utama dengan kuih cek mek molek mengandungi natrium paling sedikit. Sebaliknya, makanan utama mendominasi kategori paras natrium tinggi. Hal ini mungkin disebabkan oleh penggunaan pelbagai perasa dan sos dalam penyediaan makanan, berfungsi sebagai pengawet, penambah rasa dan warna serta penstabil makanan.

Kandungan natrium tertinggi didapati terkandung dalam gulai ikan masin (1584.3 mg/100 g). Penemuan ini boleh meningkatkan kesedaran dalam kalangan pengguna dan penyedia makanan, menggalakkan usaha bersama dalam strategi pengurangan garam oleh itu berpotensi mengawal penyakit tidak berjangkit di Malaysia.

**EVALUATION OF SALT CONTENT IN MEALS AVAILABLE AT
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ABSTRACT

Meals sold in campus cafeteria are source of food for students, staff and lecturers, particularly during lunch hour. People tend to have lunch on campus during lunch hour to save time and energy compared to dining off-campus. The addition of table salt and sauces to food is very common in Malaysian practices and has been identified as a major contributor to sodium intake. Despite its essential role in nerve and muscle function, consuming excessive sodium can have detrimental health effects. This study aimed to analyse the salt content of meals available in campus cafeterias, categorised into two groups, namely main meals and snack foods to encourage consumers to make informed food choices. Main meals (0.975 g/100 g) were found to have higher average salt content compared to snacks (0.562 g/100 g). Food items were categorised into three levels of sodium, low (<120 mg/100 g), medium (120-599 mg/100 g) and high (>600 mg/100 g). 60% of the selected food items in this study fell within the medium sodium level. In the low sodium level category, snacks were the main contributors with *cek mek molek* containing the least sodium. In contrast, main meals dominated the high sodium category. This may be due to the use of various seasonings and sauces during cooking, which often serve as preservatives, flavour and colour enhancers and stabilizers. The highest sodium content was observed in *gulai ikan masin* (1584.3 mg/100 g). These findings can raise awareness among consumers and food providers, encouraging collaborative efforts in salt

reduction strategy therefore potentially reduce the prevalence of non-communicable diseases in Malaysia.

CHAPTER 1 : INTRODUCTION

1.1 Background of Study

Salt is an essential ingredient in food preparation as it contributes to flavours, texture and colour of foods as well as preserving food in the long term. Salt has been used since pre-history and until today, it is still routinely added during cooking and in processed foods (Durack et al., 2008). Based on a survey in 2012 among health staff in Malaysia, the study found discretionary salt and sauces including soy sauce, oyster sauce, stocks, seasoning, *sambal* and pastes contributed 60% of salt in the diet and processed foods contributed 37% of salt (WHO, 2019). These different kinds of salt sources enhance the sensory properties of foods and influence food palatability in consumers. Malaysian meals usually have salty taste, in accordance with the perception that consumers prefer salty foods. According to the survey by Ministry of Health Malaysia in 2019, the amount of sodium consumed, mainly in the form of salt, is well above the recommended intake for good health (WHO, 2019).

It is well-known that salt in the market is commonly made up of sodium and chloride in which, up to 40% of the molecule are sodium. Humans require adequate amount of sodium to allow proper bodily functions, particularly for fluid balance as well as nerve and muscle functions, which obtainable through the diet (Durack et al., 2008). Nutritional labelling on packaged or manufactured food products provides information on sodium content in the foods, to ensure consumers make informed decisions before purchasing food products. On the other hand, the sodium content in freshly prepared foods such as street foods, takeaway foods and meals in school cafeteria, usually unknown. Thus, salt analysis

can be done through various laboratory methods hence sodium content can be predicted. This procedure is called chloride analysis or sodium analysis which can be done in a traditional way like titration method or through advanced method like spectrophotometry (Campden BRI, 2011).

The World Health Organization (WHO) has recommended the consumption of sodium for adults should be less than 2000 mg daily, equivalent to less than 5 g of salt per day (PAHO, 2023). According to Recommended Nutrient Intake (RNI) Malaysia 2017, sodium requirement for both men and women adults based on Adequate Intake (AI) is 1500 mg every day. However, adults can take up mostly to 2300 mg of sodium per day based on Upper Intake Levels (UL) recommended in RNI. This is the highest level of sodium intake for adults that is likely to pose no risk of adverse health effects in the general population. If the sodium intake beyond the UL, the risk of adverse effects increases as well (Kementerian Kesihatan Malaysia, 2017). 'Salt Reduction Strategy to Prevent and Control NCD for Malaysia' has been proposed as to response to WHO recommendation on salt reduction interventions which aims to reduce mean population salt intake by 30% by 2025 for the prevention and control of noncommunicable diseases. Based on previous report by Ministry of Health Malaysia in 2019, even though the Salt Reduction Strategy have been implemented with high fidelity and quality components, the impact is still limited by moderate implementation and low public outreach (WHO, 2019).

One billion people suffer from hypertension worldwide which leads to heart attacks and strokes. In the current scenario, elevated blood pressure kills an estimated nine million people every year. Systolic blood pressure of 140 mmHg or higher has been related with 58.3% haemorrhagic stroke related death, 50.0% ischaemic stroke related death, and 54.5%

ischaemic heart disease related death. Addressing the risk factors for elevated blood pressure effectively and promptly, can significantly improve both health and the economy by averting negative health outcomes. A study by Cook et al. (1995) on the impact of population-wide lifestyle modification suggested that a reduction of 2 mmHg diastolic blood pressure in the mean population distribution with modest salt reduction would decrease the prevalence of hypertension by 17%, the risk of coronary artery disease by 6% and the risk of stroke by 15% (Cook et al., 1995). CVD has become a leading cause of death in Malaysia for the past few decades. The rapid economic growth, coupled with a change in socio-demography, has led to the adoption of new lifestyles, food habits and dietary pattern. The National Health and Morbidity Survey (NHMS) report in 2015, stated that the overall prevalence of hypertension including known and undiagnosed cases among adults aged 18 years and above was 30.3%. The survey also reported an increase in prevalence with age from 6.7% in the 18 to 19 years age group meanwhile among the 70 to 74 years age group, the prevalence of hypertension reaches a peak of 75.4%. According to data from the 2014 Malaysian Burden of Disease Study, high blood pressure was the leading cause of mortality for both men and women, accounting for 42.2% of deaths and 21.6% of disability-adjusted life years (DALY) (Romli, 2018). This study was carried out to determine the salt content in meals available at Universiti Sains Malaysia (USM) Health Campus. The data can be utilised for future research and interventions on the sodium content in meals available in public institutions as well as raising awareness among the general public.

1.2 Problem statement & Study rationale

Addition of salt and salty sauces to foods are very common in Malaysian practices. It has been identified as the major sources of sodium in the Malaysian diet. The top sodium sources in the Malaysian diet that have been identified to cause high salt consumption including light soy sauce, dark soy sauce, oyster sauce, tomato and chilli sauce. In the same study, the researchers found that soy sauce and ketchup were the most popular sauces sold and consumed in Malaysia. The highest sodium content was prawn sauce, commonly known as *budu* or *cencalok*, followed by light soy sauce, and salty soy sauce (Shahar et al., 2019). These sauces can be consumed as condiments or can be used as food enhancers in cooking.

This study is conducted to determine whether meals sold in campus cafeteria contain the desired salt level or vice versa. In comparison to packaged foods sold in the convenience stores, information in salt content represented by sodium level is available through food labels for consumers to make an informed decision before purchasing, meanwhile no information regarding salt content available for freshly prepared meals. Thus, consumers are less aware of the salt content in the meals. Meals sold in campus cafeteria are chosen since they are easy to grab and accessible to students, lecturers, staffs and workers in USM Health Campus. Based on observations, most people tend to have lunch during lunch hour, to save time and energy from eating outside the campus. Other than that, meals in cafeteria are available at reasonable and affordable price compared with outside restaurants, which is beneficial, especially for students. Therefore, this study aims to analyse the salt content in meals available in campus cafeteria through laboratory

methods and the meals was divided into two categories, which are main meals and snack foods.

1.3 Significance of Research

This study determined the salt content of each selected meal sold at the campus cafeteria. The salt content in the meals then was analysed by using laboratory methods which were Mohr's method and Volhard's method. This information is important since meals sold in campus cafeteria have no information on salt content while they are accessible, convenient, low cost with various range of options. Other than that, the presence of salt in foods may affect consumer's preferences to foods. Not only salt is attributable to tastiness, but other sensory attributes are also influenced by salt addition as perceived by consumers. A study found that consumers are more likely to choose foods that have greater taste rather than health concern. This is consistent with literature that people who claimed salt alternatives that are not giving a good taste did not influence in reducing their salt intake even though they are aware of the health benefits (Nguyen & Wendy, 2019).

This study aims to categorise the salt level in each selected meal and snack into three different categories, specifically low, moderate and high. By analysing the distribution of salt levels across these categories, we can gain insights into the salt content of meals and snacks offered at the campus cafeteria. Therefore, this data can serve as the foundation for potential adjustments to promote healthier meals options in the campus. We should have known that publicly funded institutions including schools, workplaces and hospitals are a key setting for creating healthy food environments through nutrition standards (Rosewarne et al., 2022). This data will be helpful to improve salt reduction strategies in freshly prepared meals, especially in public institutions.

1.4 Research Questions

1. Which food category has the higher mean of salt content?
2. What is the salt level content of the meals offered at the cafeteria of the USM Health Campus according to the classification from low to high?

1.5 Research Objective

1.5.1 General Objective

To determine the salt content in meals available at the cafeteria of Universiti Sains Malaysia (USM) Health Campus.

1.5.2 Specific Objectives

1. To determine the average salt content in meals from different categories (main meal, snack foods) available in the cafeteria of USM Health Campus.
2. To compare the average salt content between different food categories, main meal and snack foods.
3. To categorise the foods according to the salt content level from low to high.

CHAPTER 2 : LITERATURE REVIEW

2.1 Adverse Effects of High Salt Intake on Health

Salt has various roles that provide many benefits to food products including preservation, contributions to flavour, texture and colour. Salt is the main source of sodium in human diet, which is essential for nerve and muscle function. Sodium also involves in the regulation and retention of fluids in the body and consequently influences blood pressure and volume (James and Lewis, 2019).

However, excessive salt intake can be a threat to health. Several studies have supported the idea that excessive salt intake is associated with many kinds of diseases development, commonly cardiovascular disease (CVD). High salt intake has been related to the development of hypertension which is associated with the risk of the onset of cardiovascular disease. For some individuals, high salt intake may not affect their overall health status but for sub-groups with certain health conditions, such as hypertensives, elderly and ethnic group like black individuals, they are more susceptible to cardiovascular disease (Durack et al., 2008).

Regulation of blood pressure in the body requires the kidney to excrete or conserve enough sodium to ensure sodium content is at normal level, consequently, affects the blood volume. Thus, if sodium is present excessively in the body, it will be generally excreted. Any rise in blood volume influenced by too much salt will raise renal perfusion, glomerular filtration rate, arterial pressure and excretion of sodium and water. There is an upper limit to the amount of sodium that can be excreted, therefore, too much salt intake

leads to water retention. If the water retention is greater than water excretion, this may result in tissue damage and hypertension in individuals (Durack et al., 2008).

2.2 Role of Salt in Food Processing

Salt, beyond its crucial roles in human physiology, nutrition and health which as a major source of sodium, is also of great importance in both home cooking and industrial food processing. This subtopic will explore the role of salt in several different areas.

Dehydration processes often require salt during curing. Salt plays an important part by reducing the water activity, A_w in foods, consequently deprives microorganisms of the water they need for growth and reduces enzymatic activity (Elias et al., 2020). A_w represents the ratio of vapour pressure of water in a food to the vapour pressure of vapour water at the same temperature, essentially measuring the availability of water for enzymatic reactions, microbial growth and metabolism. Each microbial species has a minimum A_w below which it cannot grow. When salt is added, cells experience osmotic shock, leading to plasmolysis or water loss. This loss of turgor pressure results in the cessation of cells growth, death or entry into a dormant state. However, salt must be added judiciously to maintain product acceptability while effectively suppressing microbial growth (Durack et al., 2008).

Despite its salty flavour, salt can also enhance other flavours. It can balance sweetness in food and help suppress flavours, such as bitterness (Elias et al., 2020). Salt can significantly make sweet foods taste sweeter by suppressing the perception of bitterness, thus highlighting the sweetness. This explains why a small amount of salt is often added to

sweet baked goods. In bitterness suppression, salt interacts with bitter-tasting receptors on the taste buds, lowering the perception of bitterness while simultaneously enhancing the overall flavour of the food. Furthermore, salt acts as a taste amplifier for savoury flavours by stimulating the taste buds, especially in meats, broths, and stocks where it brings out the natural flavours. Salt interacts with food molecules, increasing their evaporation and allowing the aroma to reach the nose more quickly. Since taste and smell are closely intertwined, the enhanced aroma significantly intensifies the overall perception of flavour (Garcia, 2024).

Other than its role in flavour and preservation, salt functions as a texture enhancer and binding agent. In meat and meat products, salt can increase the water-holding capacity, tenderises raw meat, and improves the binding of batters in processed meats (Elias et al., 2020). Salt allows activation of proteins to improve hydration and water binding capacity. Protein binding properties are enhanced, improving texture and increasing meat viscosity, which facilitates the formation of a stable batter. The combination of salt and sodium nitrite contributes to colour maintenance in cured meats. In terms of tenderising effects, salt causes myofibrils in meat to swell, enhancing the water-holding capacity (Durack et al., 2008).

In bakery products, salt strengthens gluten, making it more stable and less extensible and sticky, while also controlling the fermentation rate and increasing shelf life. The primary function of salt in bread is to enhance the desirable flavours and mask off-flavours. Salt helps control yeast activity and strengthens the protein matrix that contributes to the bread crumb structure. Furthermore, salt slows down fermentation rate, resulting in less sugar being metabolised into acids. This leads to a higher dough pH and a darker crust.

Salt also enhances the stability of wheat gluten, making it less extensible and reducing the sticky texture of bread. This may be due to the fact that gluten is composed of negatively charged proteins that repel each other. The positive-charged sodium ions in salt play a role in bringing these protein molecules closer to each other (Elias et al., 2020).

2.3 Salt Content in Different Type of Meals

The study of determination of salt content has been done in many countries including Malaysia, but with different kind of meals and with larger samples. The sodium analysis has been done in street foods in Malaysia including snacks, main meals and desserts. The top main cooking methods used in preparation of the street foods are deep-frying which contributed the highest in the study, followed by steaming, pan frying and boiling. According to this study, the average sodium content in the snack category from both West and East Malaysia had the highest sodium content, followed by main meal and dessert category with the least sodium content in the list. This result may be due to the fact that processed foods are used in the street foods and fish-based foods contained the highest salt content (Haron et al., 2022). In another study of analysing sodium content in sauces, it was also discovered that the highest sodium content was displayed in fish or prawn sauce (Shahar et al., 2019). The main meal category includes noodles and rice, which have been fried and some have been served with gravy, which contributes medium to high amounts of sodium. In the dessert category, *apam balik*, a Malaysian Heritage Food contained medium sodium content, which is associated with the use of sodium bicarbonate in its preparation (Haron et al., 2022).

Foods prepared outside the home are typically thought to have more salt than the meals served at home, with an approximate estimation indicated that 15% of the salt consumed among UK population comes from foods eaten outside the home (Guthrie, Lin, & Frazao, 2002 ; He & MacGregor, 2010). According to the study conducted in United Kingdom, a very high level of salt intake found in hot takeaway meals, with a single portion of an average takeaway meal contained more than half of the Food Standards Agency, UK. Pizzas were characterised by the highest salt content per portion, followed by Chinese meals, Kebabs and Indian meals. In fact, none of the 23 analysed takeaway meal types in the UK contained less than one third of the target which is 6 g per day (Jaworowska et al., 2012). According to Mattes (1997), salt and other sodium containing seasonings are ubiquitous components of the diets around the world and it is believed by many, that salt enhances the palatability of foods. Similar study in Portugal, the salt content of school meals is high as well, ranging from 2 to 5 times more than the Recommended Dietary Allowances for children. Soups and main courses are the leading sources of salt in school meals. Other than that, a very high percentage of students consider meals to be neither salty nor lacking in salt which proven that they have accustomed to the great intensity of salt consumed (Viegas et al., 2015).

These studies highlighted that salt reduction strategies should be implemented, which aimed at the food industry, and catering services (Viegas et al., 2015; Jaworowska et al., 2012; Haron et al., 2022). In order to encourage consumers to make healthier choices in purchasing prepared foods away from home, it is crucial to disseminate information on the high sodium content of foods to the public. This effort can be done through advertisements and social media which can be accessed by people around the world. The public needs to be

informed that sodium consumption in foods must be limited to 2000 mg per day (Haron et al, 2022).

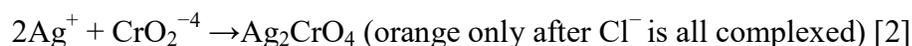
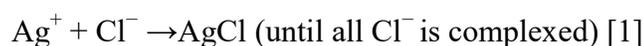
2.4 Measurement Techniques for Salt Analysis

Precipitation titration methods are well suited for any foods that may be high in chlorides. Salt in foods may be estimated by titrating the chloride ion with silver. Processed foods such as cheeses and meats are suitable for this analysis because of the presence of added salt. Then, the salt content will be estimated by calculation. Since these manual methods are easily automated, there is a potential that both methods will be continuously used in the analytical food laboratory (Nielsen, 2010). These precipitation methods are namely Mohr's titration method and Volhard's titration method. Both methods analyse chloride to infer the total sodium or sodium chloride content in samples. For direct sodium analysis, other methods should be used by using specific devices particularly inductively plasma optical emission spectrometry (ICP-OES) and portable salt meter that uses electrical conductivity (Viegas et al., 2015; Jaworowska et al., 2012; Haron et al., 2022). However, due to the limited availability of these devices in the nutrition lab, traditional methods are preferred since they are low in cost. According to WHO, the disadvantage of chloride analysis is that the accuracy in determining sodium content is quite low therefore, direct sodium analysis is more favourable.

2.4.1 Mohr's Titration Method

Historically, the Mohr's method is a manual titration method using silver nitrate as a titrant and potassium chromate as a colour indicator. A volumetric burette is used to

manually add silver nitrate titrant to a sample that has chloride analyte as the indicator, during titration. This leads to the formation of silver chloride, AgCl precipitate in the solution since silver ions and chloride ions have been reacted. Additionally, AgCl is insoluble in water thus it will remain in the solution. Silver nitrate solution will be added until all the chloride ions are reacted. The presence of silver ions due to the excess addition of silver nitrate, results in the binding of silver ions to the potassium chromate colour indicator. That is why the solution change colour to red, which signals the endpoint of the titration. The calculation of chloride concentration will be obtained from the volume of silver nitrate that is added and it can be used to infer sodium or sodium chloride content (Romli, 2018). The chemical equation for this method is as following (Nielsen, 2010):

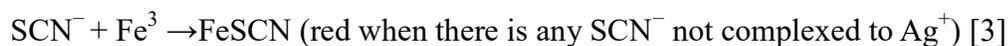
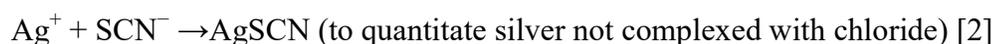
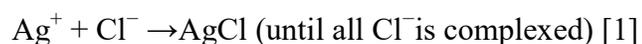


The limitation of this method is that it relies on subjective interpretation of the colour indicator change. This leads to the overestimation of salt content in food samples. Other than that, the accuracy of the measurement of the titrant that is used is another challenge in this method. However, the investment to perform this method is very low, with silver nitrate titrant, colour indicator, volumetric burette and other necessary glassware is low (Romli, 2018).

2.4.2 Volhard's Titration Method

This method applies indirect titration, which is known as back titration. Potassium thiocyanate will be used to determine the concentration of chloride ions in a solution. A back titration is a titration method where the concentration of an analyte is determined by

reacting it with a known amount of excess reagent. The excess reagent that remains is then titrated with another second reagent. Silver nitrate solution will be added to the solution containing chloride ions until excess that results in precipitation of silver chloride. The moles of silver nitrate added are known to exceed the moles of sodium chloride present in the samples so that all the chloride ions present will react. Ferric ion (Fe^{3+}) acts as an indicator that is added into the solution and will be titrated with potassium thiocyanate solution. The colour of the titrate remains pale yellow as the excess silver ions react with thiocyanate ions, forming silver thiocyanate precipitate. The formation of dark red complex marks the endpoint of titration, since all the silver ions have reacted. The colour change is caused by the reaction of excess thiocyanate with ferric ions. The determination of chloride ions concentration is obtained by subtracting the titration findings of the moles of silver ions that reacted with the thiocyanate from the total moles of silver nitrate added to the solution (Romli, 2018). The chemical equation for this method is as following (Nielsen, 2010):



This method is preferable when the pH solution after the sample has been prepared is acidic (Romli, 2018).

2.4.3 Limitation

The limitation of Mohr's method and Volhard's method is, every method must be performed according to the pH solution. This is because both indicators react differently to

different pH solution. If Mohr's method is conducted in acidic solution, it will cause a great decrease of chromate ions intensity therefore the excess silver ions cannot react sufficiently with chromate ions to form brick red colour at the endpoint of titration. On the other hand, if Volhard's method is carried out in basic solution, this will lead to the formation of iron (III) hydroxide from ferric alum indicator, which should be reacted with thiocyanate anions to form red colour to indicate the endpoint of titration (Samal, 2020). Concisely, the presence of different ions in different pH solutions will interfere with the formation of coloured precipitate, that can cause significant error during data recording. To conclude, Mohr's method is preferred for neutral or basic food samples meanwhile Volhard's method is preferred for acidic food samples.

These studies highlighted that salt reduction strategies should be implemented, which aimed at the food industry, and catering services (Viegas et al., 2015; Jaworowska et al., 2012; Haron et al., 2022). In order to encourage consumers to make healthier choices in purchasing prepared foods away from home, it is crucial to disseminate information on the high sodium content of foods to the public. This effort can be done through advertisements and social media which can be accessed by people around the world. The public needs to be informed that sodium consumption in foods must be limited to 2000 mg per day (Haron et al., 2022).

CHAPTER 3 : RESEARCH METHODOLOGY

3.1 Research Design

The type of study design that was applied in this study was experimental study. The laboratory methods involved were Mohr's method and Volhard's method. The salt content then was calculated by using a specific formula which yield the result in the form of percentage. Then, the percentage was used as the reference to determine the salt mass in every meal, in gram unit. After that, sodium, Na content was estimated from the calculated salt mass, NaCl.

3.2 Study Area

The meals were purchased from cafeteria available in Health Campus of Universiti Sains Malaysia, specifically Murni Cafeteria and Harmoni Cafeteria. These location were chosen since students, lecturers and staff mainly go to these cafeterias during lunch hour. Other than that, researchers do not need transportation to go to the cafeteria since both are located inside the campus and near the hostel.

This experiment was conducted in nutrition lab, Pusat Pengajian Sains Kesihatan, Universiti Sains Malaysia (Kampus Kesihatan), 16150 Kubang Kerian, Kota Bharu, Kelantan. This location was chosen because of the availability of the necessary apparatus and chemicals as well as the ease with which the sample could be stored. Additionally, there are skilled personnel on hand to monitor the experiment's progress and to ensure that the outcome is definite.

3.3 Sample Size Estimation

40 meals samples were analysed in this study and approximately 15 to 20 g of each menu was collected from the cafeteria. Then, the foods were divided into their respective categories, which are main meals and snack foods. In this study, 20 main meals and 20 snack foods were purchased for analysis.

3.4 Research Tool

The reference for Volhard's method was from **United States Department of Agriculture (USDA), Quantitation of salt (NaCl)**, while the reference for Mohr's method was the **Indian Standard procedure of Mohr's method, IS 3507 – Mohr's Method**.

3.5 Data Collection Method

Both procedures were slightly modified considering the different type of food sample used in this analysis and the availability of material and equipment in USM nutritional lab. Firstly, the pH level of the purchased meals were determined by using universal pH paper. This is because, there are two different approaches in determining salt content depending on the pH levels of the samples and each method requires specific indicator. For samples with acidic pH which is <7 , Volhard's Method was used meanwhile for samples with neutral or basic pH which is ≥ 7 , or precisely 7 to 10, Mohr's Method was used (Romli, 2018 ; Science Ready, 2024). Initial reading and final reading of respective required titrants were recorded in tables before proceeding with salt percentage calculations. The purchased samples included solid and semi-solid samples. For solid

samples, foods were initially purchased in their own packaging and a small amount of the sample was then separated into different small food container for analysis. The small amounts taken were first estimated by naked eye before being transferred to analytical balance for weighing, that was further explained in sections 3.5.1.3 and 3.5.2.3. Semi-solid samples consisted of solid food with its accompanying sauces or gravy such as *ayam masak merah*, and *ikan patin masak tempoyak*. For this type of sample, researcher self-collected the samples from the cafeteria using plastic bags. Only one piece of the protein, such as a whole fish, or a particular chicken part like a thigh or a wing, was taken for experimentation along with two to three ladlefuls of its gravy and transferred into the same plastic bag. For dishes containing small pieces of protein like cuts of chicken meats, an estimated amount of protein equivalent to three tablespoons was taken, along with two ladlefuls of its gravy. The amount of sample taken was estimated based on a typical individual serving. This experiment only required the edible portion of foods. Inedible portions like bones were identified and removed (Haron et al., 2022). All readings in this experiment were repeated three times to improve accuracy and precision.

3.5.1 Volhard's Method

3.5.1.1 Chemical Preparation

For silver nitrate solution, 17.04 g of silver nitrate were dissolved in distilled water in a 1 L volumetric flask. Then, the solution was diluted to volume. For potassium thiocyanate indicator, 9.72 g of the reagent were dissolved in distilled water in a 1 L volumetric flask and diluted to volume. Followed after was dilution of nitric acid with 1:1 ratio of acid to water. 500 mL of nitric acid were added to 500 mL of water and mixed carefully to obtain 1 L of diluted nitric acid. For ferric alum indicator, 5g of ammonium

ferric sulphate weighed and transferred into 50 ml distilled water. 5 ml concentrated nitric acid was added and the mixture was slowly boiled until the brown colour fumes (nitrous fumes) were expelled. The solution was left cooled at room temperature and diluted to 200 ml. For 5% potassium permanganate solution, 50 g of potassium permanganate were added to a 1 L volumetric flask and diluted to volume. These solutions were kept in actinic glassware to protect the solutions from light. Lastly, to prepare 5% potassium chromate solution, 5 g of potassium chromate were added to 100 mL volumetric flask and diluted to volume. All the solutions were stored at room temperature.

3.5.1.2 Solution Standardisation

- **Silver Nitrate (AgNO₃) Solution**

0.2500 ± 0.0500g of potassium chloride (KCl) were weighed and transferred into a 250 mL Erlenmeyer flask and dissolved in 40 mL of water. 1 mL of potassium chromate (K₂CrO₄) was added as indicator. The potassium chloride solution was titrated with silver nitrate solution until solution turns permanent light brown, salmon-like colour.

- **Potassium Thiocyanate (KSCN) Solution**

25 mL of the standard silver nitrate solution were transferred into a 300 mL Erlenmeyer flask then 80 mL of water were added followed by addition of 15 mL of diluted nitric acid (HNO₃) solution. 2 3mL of ferric alum indicator were pipetted into the same flask as indicator. The solution was titrated with potassium thiocyanate (KSCN) until solution turns to a permanent light brown, salmon-like colour.

3.5.1.3 Sample Preparation

Firstly, all inedible portions from food samples were removed. Solid foods samples were homogenized using a food processor for approximately 2 to 5 minutes, or until they were finely ground into a powder-like texture. The finely comminuted sample was weighed about 2.5 g on a weighing boat by using analytical balance and added into a 300 mL Erlenmeyer flask. For semi-solid samples, the sample size was equivalent to a typical daily serving intake, for example, a single serving of fish with 5 tablespoons of its accompanying sauce. In this experiment, about 60 mL of the liquid portion were extracted and all the solid edible portions were blended together in a food processor. About 3 g of the food samples were weighed and transferred into 300 mL Erlenmeyer flask.

3.5.1.4 Procedure

25.0 mL of 0.1N silver nitrate (AgNO_3) solution was added to the flask and swirled until sample and solution were in intimate contact. Then, 15 mL of nitric acid (HNO_3) was added. Sufficient boiling chips were added, and the mixture sample was boiled until digested. A teaspoon of lactose was added and solution turned from a cloudy white colour to yellow. Enough potassium permanganate (KMnO_4) solution were added while boiling to turn the solution dark brown for several minutes. The boiling process was continued until colour disappeared. Then, small portions of potassium permanganate (KMnO_4) were added continuously to the solution until a persistent dark colour retained for several minutes before clearing. The sides of the flask was washed with distilled water. A teaspoon of lactose was added if the colour remained, until the colour disappeared. After that, water was added to adjust total volume of 25 mL using the graduations on the flask. Solution was boiled for 5 minutes and left it cool to room temperature in the fume hood. The neck of

the flask was rinsed again and diluted with water to a total volume of 150 mL using the graduations on the flask. 2 mL ferric ammonium sulfate indicator was added using a disposable transfer pipette and the solution was swirled to coagulate the precipitated silver chloride (AgCl). Excess silver nitrate was titrated with potassium thiocyanate solution to a permanent, salmon-colored, end point. However, if titration with potassium thiocyanate (KSCN) was less than 2 mL, the procedure was repeated with a smaller sample weight (USDA, 2023).

3.5.1.5 Calculation

$$\text{Salt percentage (NaCl)\%} = \frac{[25.0\text{mL} - (\text{mL KSCN})(R)](N \text{AgNO}_3)(5.84)}{\text{Sample Weight}}$$

$$\text{Where } R = \text{ratio of } \frac{\text{mL AgNO}_3}{\text{mL KSCN}}$$

3.5.2 Mohr's Method

3.5.2.1 Chemical Preparation

In Mohr's method, the chemicals used were potassium chromate as indicator and silver nitrate solution as the titrant. For potassium chromate indicator, 5 g of potassium chromate crystals were dissolved in 100 mL of distilled water and shaken until well mixed. To prepare 0.1 N silver nitrate solution, 1.699 g of silver nitrate crystals were dissolved in 100 mL of distilled water and mixed well by shaking it. Both solutions were kept in amber-colored glass bottles to prevent direct light exposure (IS 3507 – Mohr's Method, 2021).

3.5.2.2 Solution Standardisation

- **Silver Nitrate (AgNO₃) Solution**

0.584 g of sodium chloride (NaCl) was weighed and transferred into a 100 mL volumetric flask. 80 mL of distilled water was added to the flask and shaken well, followed by the addition of distilled water up to the calibrated mark of the flask. Next, 10 mL of the sodium chloride solution was extracted and poured into a conical flask for titration. 1 mL of potassium chromate solution was pipetted into the solution and titrated with silver nitrate solution until solution turned reddish brown (IS 3507 – Mohr's Method, 2021).

3.5.2.3 Sample Preparation

Mohr's method is a direct titration method to be compared to Volhard's method. For solid food samples, the foods were ground in a food processor to homogenize the samples. For semi-solid samples, the same sample preparation as in Volhard's method was used. Then, about 5.0 g of the sample was weighed and added to a 300 mL conical flask. 100 mL of boiling distilled water was transferred into the same conical flask.

3.5.2.4 Procedure

The flask containing the sample was swirled to mix the contents. The mixing process was continued for 5 to 10 minutes with occasional swirling. 1 mL of 5% Potassium Chromate indicator solution was added into the flask and the solution was swirled to mix the content properly. 0.1 N Silver Nitrate solution was added to a burette and initial reading was recorded. Titration was started by adding the silver nitrate solution into the conical flask, a drop at a time with vigorous agitation of the flask. Titration was stopped once the solution turned to a reddish-brown colour which marked the endpoint of the titration. The final burette reading was recorded (IS 3507 – Mohr’s Method, 2021).

3.5.2.5 Calculation

$$\text{Salt percentage (NaCl)\%} = \frac{(\text{Final burette reading} - \text{Initial burette reading}) \times N \text{ AgNO}_3 \times 5.84}{\text{Sample Weight}}$$

3.5.3 Determination of salt content

To determine the salt content in the meals, the obtained salt percentage was converted to salt mass in grams per 100 grams of the food sample, salt mass (g)/100g.

3.5.4 Sodium Estimation

By assuming salt in every meal as sodium chloride, sodium content was predicted from the salt mass calculated from the salt percentage. Sodium content per 100g of food sample was determined using the following calculation:

$$\text{Sodium content, Na (g)} \times 2.54 = \text{Equivalent salt content (g)}$$

2.54 is the ratio of the atomic mass of salt, 58.44 g/mol to the atomic mass of sodium, 22.99 g/mol which accounts for the chloride content of salt (Campden BRI, 2011). The sodium content was then converted to milligrams by multiplying the value by 1000, as 1g is equivalent to 1000 mg.