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FACULTY OF APPLIED SCIENCES

SCIENTIFIC PROJECT COLLOQUIUM

2024



Final Year Project Colloquium 2024
Faculty of Applied Sciences,
Universiti Teknologi MARA,
Perak Branch Tapah Campus,
35400 Tapah Road, Perak, Malaysia.

Colloquium date 12 July 2024

Publication date 30 October 2024

Proceedings of Extended Abstracts

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e-I.S.B.N: 978-629-97630-4-8

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Preface

The Scientific Project Colloquium offers a platform for publishing Diploma Science final year projects (FYP). The objective is to effectively distribute research findings throughout all scientific disciplines. The primary objective of including final year projects into the course curriculum is to encourage students to put their theoretical knowledge into practical applications.

We would like to express our gratitude to our primary establishment, the Faculty of Applied Sciences and Universiti Teknologi MARA, Perak Branch, for their invaluable assistance.

Lastly, we would like to express our gratitude to all of the authors for the tremendous help in preparing the articles, without which this undertaking would not have been completed.

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October 2024

BRASSICA OLERACEA VAR. BOTRYTIS (CAULIFLOWER) AS A REPLACEMENT FOR A WHITE RICE DIET

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Abstract: This study aims to determine the calorie content and additional nutritional benefits of cauliflower compared to white rice as well as their antibacterial properties. Brassica oleracea var. botrytis also known as cauliflower, is a commonly consumed vegetable of the Brassicaceae family that is rich in dietary fibre, vitamins, minerals, and bioactive compounds. Unlike white rice, which is high in carbohydrates and contains minimal nutritional value, cauliflower is low in calories and also offers essential nutrients for a healthy diet. The calorie contents of cauliflower and white rice was determined by food calorimetry. In this study, the cauliflower and white rice samples were burned, and the resulting energy was utilized to heat a specific amount of water. The temperature change (ΔT) of the water is used to calculate the energy in the sample. For the determination of ash content, the sample weight was recorded after a complete combustion inside the muffle furnace. As for the microbial activity, the sample of cauliflower and white rice were extracted with 50%, 60%, 70% concentrated ethanol. The pure culture of the microbes for Bacillus Subtilis and Salmonella Typhimurium was inoculated into the sterile nutrient broth to produce the bacterial inoculum. Agar diffusion method was used to detect the antibacterial activity of the samples. Cauliflowers show a relatively low value of calorie and ash content. The presence of a bioactive compound cannot be detected since there is no inhibition zone visible on the agar plate. As a result, the microbial activity of cauliflower and white rice cannot be determined.

Keywords: cauliflower, white rice, antimicrobial activity, calorie content, bioactive compound

INTRODUCTION

Two commonly consumed items that are important components of many international culinary traditions are cauliflower and white rice. Both are regarded as staple meals, however there may be differences in their nutritional profiles and possible health advantages. The purpose of this study is to compare the nutritional value, calorie content, and antibacterial qualities of cauliflower and white rice. Managing calorie intake and weight can be challenging and stressful (Camacho & Ruppel, 2017). Dieting often leads to stress as individuals restrict themselves from foods, they enjoy but are considered unhealthy for weight loss. A calorie deficit diet, which involves consuming fewer calories than the body burns, is commonly seen as an effective way to lose weight. This method forces the body to utilize stored calories, preventing excess from leading to weight gain and potentially obesity (Lee & Muda, 2019; Rowland, 2009). The principle behind this diet is straightforward. By reducing calorie intake, the body burns stored calories and fat throughout daily activities, regardless of exercise (Kim, 2021; Van De Walle Ms Rd, 2024). Each movement helps to burn fat from previous excess calorie consumption, facilitating weight loss while consuming fewer calories. A significant downside to this approach is the need to eliminate many regular foods such as rice, noodle and sugary drinks. This restriction can feel disheartening for those aiming to lose weight but fortunately there are alternatives that allow individuals to maintain their ideal weight without experiencing hunger. Rice, a staple in many diets is delicious and high in carbohydrates which keep one feeling full but also high in calories, leading many dieters to avoid it as overconsumption of rice can result in losing control over calorie intake, adding to the stress of dieting (Watanabe et al., 2013). There are numerous alternatives to traditional meals, with cauliflower emerging as popular substitute for rice (Camacho and Ruppel, 2017). Cauliflower rice is an excellent low-carb option to cut calories or increase vegetable intake (Mph, 2021). Additionally, cauliflower rice resembles the texture and taste of white rice which makes it a satisfying alternative that helps curb craving besides the antibacterial properties due to the presence of bioactive compounds like flavonoids. This substitution makes dieting less stressful and promoting healthier lifestyle.

METHODOLOGY

1.0 Materials

1.1 Plant Materials

The cauliflower used in this work was obtained from Cameron Highland meanwhile the white rice used was purchased at a nearby store under the brand Beras Faiza Emas, which is produced in Batu Pahat, Johor.

1.2 Instrumental

Furnace, oven, autoclave, blender, vacuum pump was used in this study.

1.3 Chemicals

The chemicals used for this study are ethanol, agar nutrient, nutrient broth and 70% alcohol.

2.0 Experimental

2.1 Determination of Ash content

The ground samples of cauliflower and white rice (2 g) were added to a crucible and burned in a muffle furnace at 600°C for 2h. The samples were taken from the kiln, put in a desiccator until the temperature dropped to room temperature. The samples were weighed within 1 hour after reaching room temperature and ash weight was recorded. The percentage of ash content in the sample was determine using the formula of :

$$\text{Ash content (\%)} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

Where:

W0 = Weight of empty crucible

W1 = Initial weight of crucible + sample

W2 = Final weight of crucible + ash

2.2 Determination of Calorie content

To determine the calorie content of cauliflower, the cauliflower was chopped first into small pieces and placed in the oven to dry for 15 hours at 60°C. After that, the apparatus was set up where a wire gauze is placed on a tripod and using a retort stand to hold onto a boiling tube containing 20mL of distilled water and a thermometer. The initial temperature of the distilled water in the boiling tube was recorded. Then, the dried cauliflower was placed on the wire gauze and from below the wire gauze, the cauliflower was burned off with Bunsen burner and left to combust completely. Lastly, the temperature of the distilled water was recorded once more right after the sample was burned off. The calorie content of the sample was determine using the formula of :

$$\text{Value of calorie in food} = \frac{4.2 \text{ g}^{-1}\text{C}^{-1} \times \text{mass of water (g)} \times \text{changes in temp. (}^\circ\text{C)}}{\text{mass of sample (g)} \times 1000}$$

2.3 Preparation for extraction

The ground sample of dried cauliflower and rice is soaked in 50%, 60%, and 70% ethanol for 7 days to create extractions of different concentrations. The leftover solvent was removed using a rotary evaporation to produce concentrated extract.

2.4 Preparation of Agar Plate

14 g agar nutrient powder was mixed with 500 mL of sterile distilled water and autoclaved at 70°C for 2 hours. After cooling, the mixtures were poured into sterile Petri plates up to roughly 4 mm and allowed to be set at room temperature and utilized.

2.5 Preparation of inoculum

The pure culture of the test organism such as Bacillus Subtilis and Salmonella Typhimurium was inoculated into the sterile nutrient broth to create the bacterial inoculum, which was then incubated at 37°C for 24 hours until moderate turbidity developed.

2.6 Determination of Microbial Activity using Agar Diffusion method

The microbial activities of each cauliflower and white rice extract were detected using the agar diffusion technique. Broth cultures of test bacterial species were spread on Agar Petri plates under the lab conditions. The agar surface was poked, ensuring the sample was placed in wells made in the agar medium. The extracts were placed within the holes based on their concentration, with 70% alcohol as the control variable to compare the inhibition zones of the agar plate tested with cauliflower and white rice extraction. The samples were incubated at 37°C for about 24 hours to test for antibacterial activity.

FINDINGS

Determination of Ash Content

Table 1. Data of experiment determination of ash content.

Mass of crucible 1	77.0478 g
Mass of crucible 2	73.1779 g
Mass of crucible 1 + cauliflower	79.0541 g
Mass of crucible + white rice	75.1806 g
Final weight of crucible 1 + cauliflower	77.0569 g
Final weight of crucible 2 + white rice	73.2105 g

Using the formula mentioned above:

$$\text{Ash content (\%)} = \frac{(W_2 - W_0)}{(W_1 - W_0)} \times 100$$

Where:

W0 = Weight of empty crucible

W1 = Initial weight of crucible + sample

W2 = Final weight of crucible + ash

$$\text{Ash content in cauliflower (\%)} = \frac{(77.0569 - 77.0478)}{(79.0541 - 77.0478)} \times 100$$

$$\text{Ash content in cauliflower (\%)} = 0.46 \%$$

$$\text{Ash content in white rice (\%)} = \frac{(73.2105 - 73.1779)}{(75.1806 - 73.1779)} \times 100$$

$$\text{Ash content in white rice (\%)} = 1.18 \%$$

The ash content of cauliflower and white rice is important for the study to determine if cauliflower is suitable and appropriate to substitute white rice. The experiment was done firstly by grinding dried cauliflower and white rice into fine powder. Then, 2 g of the samples was weighed and poured into crucibles, respectively. After that, the crucibles are placed in the furnace, the temperature was set to 600 °C for 2 hours. (*Determination of % Ash / Public / Clemson University, South Carolina, 2024*). Later, it was found that the ash content % of cauliflower is smaller than white rice. The ash content % in food shows the mineral content, nutritional value, degree of processing, quality control, and compliance of the food regulatory which can be an indicator of the quality of the food we consumed. High ash % indicates excessive processing, mineral imbalance, impurities, and reduced nutritional value in a food.

Therefore, cauliflower experienced less food processing, has a better nutritional value, and balanced mineral content compared to white rice. Effectively, it is proven that cauliflower is a good substitute for white rice as it offers beneficial nutrients and for daily consumption.

Determination of Calorie Content

Table 2. Data of experiment determination of calorie content

	Cauliflower	White rice
Mass of sample	1.0069 g	1.0056 g
Initial temperature	26°C	26°C
Final temperature	47°C	77°C
Changes in water temperature	21°C	51°C

Cauliflower has lower calories compared to white rice. This can be shown by the result obtained from the calculation (Calorie Lab, n.d.):

$$\text{Value of calorie in food} = \frac{4.2 \text{ g}^{-1}\text{C}^{-1} \times \text{mass of water (g)} \times \text{changes in temp. (}^{\circ}\text{C)}}{\text{mass of sample (g)} \times 1000}$$

$$\text{Value of calories in cauliflower} = \frac{4.2 \text{ g}^{-1}\text{C}^{-1} \times 20 \text{ g} \times 21^{\circ}\text{C}}{1.0069 \text{ g} \times 1000} = 1.75 \text{ kJ g}^{-1}$$

$$\text{Value of calorie in white rice} = \frac{4.2 \text{ g}^{-1}\text{C}^{-1} \times 20 \text{ g} \times 51^{\circ}\text{C}}{1.0069 \text{ g} \times 1000} = 4.26 \text{ kJ g}^{-1}$$

The result of the calorie content determination revealed that the white rice contains a significantly higher number of calories compared to cauliflower. This finding aligns with the study's objectives, indicating that cauliflower's calorie content is more favorable, making it an excellent substitute for white rice. Cauliflower serves as a viable alternative due to its lower calorie count while still providing a satisfying feeling of fullness when consumed. Cauliflower can be prepared in various ways similar to rice dishes. This may help in preventing chronic illnesses such as diabetes. Individuals can achieve a more balanced nutritional profile potentially contributing to a reduction in the country's obesity rate.

Determination of Microbial Activity

Antibacterial activity of cauliflower and white rice was analyzed against Gram-positive and Gram-negative microbes such as *Bacillus Subtilis* and *Salmonella Typhimurium* using agar diffusion method. According to the previous research the antibacterial properties of cauliflower are attributed to its high content of antioxidant compounds like flavonoids because cruciferous vegetables act as a good source of natural antioxidants due to their high levels of carotenoids, tocopherols and ascorbic acid. (S & A, 2023). Flavonoids are a class of polyphenolic compounds found abundantly in cauliflower that have been shown to have potent antimicrobial effects against a variety of pathogenic bacteria. The presence of these bioactive flavonoids contributes to cauliflower's ability to inhibit the growth of harmful bacteria. (Shamsudin et al., 2022). White rice also contains flavonoids as a bioactive compound but significantly lower than cauliflower. Regrettably, the analysis was unable to confirm the presence of flavonoids in both cauliflower and white rice samples. This absence of inhibition zones in the conducted assays indicates a lack of antimicrobial activity associated with flavonoids in these samples, leading to a negative's outcomes in the evaluation. These findings suggest that further investigation may be necessary to explore the phytochemical profiles of these foods and their potential health benefits.

The negative result may be attributed to the use of different varieties of cauliflowers and rice compared to previous research that demonstrated the antibacterial properties of these foods. Variations of the phytochemical composition, particularly flavonoid content, could lead to differences in the observed antimicrobial activities. Additionally, factors such as storage, preparation technique and specific bacteria strain used may influence the results that contribute to the discrepancies between the current findings and earlier studies. Brassicaceae species contain a wide range of cauliflower including white, green, orange, purple and many more. Studies have shown agricultural practices can influence the nutrient composition of the rice grain. (Bhullar & Gruissem, 2013). Water extraction and the use of more potent ethanol also helped in the extraction process to pull out more bioactive compounds of flavonoids, which explains why the results are not as expected because we only used ethanol extraction and the ethanol concentration was insufficient to extract the bioactive compound. (Plaskova & Mlcek, 2023). Figures and tables below tabulated the negative result of the microbial activity of cauliflower and white rice.



Figure 1. No appearance of inhibition zone in various concentrations of cauliflower against Bacillus Subtilis and Salmonella Typhimurium.

Table 3. Microbial activity of cauliflower against Bacillus Subtilis and Salmonella Typhimurium.

Type of sample	Cauliflower extract		
Percentage of concentrations (%)	50%	60%	70%
Inhibition zone Bacillus Subtilis (mm)	0	0	0
Inhibition zone Salmonella Typhimurium (mm)	0	0	0

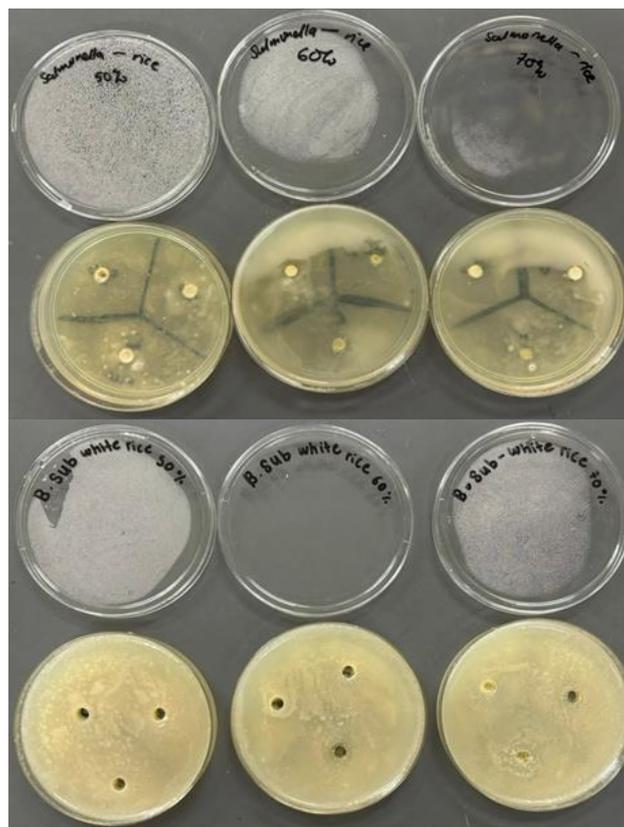


Figure 2. No appearance of inhibition zone in various concentrations of white rice against Bacillus Subtilis and Salmonella Typhimurium.

Table 4. Microbial activity of white rice against Bacillus Subtilis and Salmonella Typhimurium

Type of sample	White rice extract		
Percentage of concentrations (%)	50%	60%	70%
Inhibition zone Bacillus Subtilis (mm)	0	0	0
Inhibition zone Salmonella Typhimurium (mm)	0	0	0

CONCLUSIONS

Cauliflower has shown relatively lower value of calorie content and ash percentage compared to white rice. Cauliflower has emerged as an effective option for those who seek to reduce their calorie and carbohydrate intake while maintaining a healthy diet. Moreover, cauliflower provides various nutritional benefits to its consumer compared to white rice. The analysis was unable to confirm the presence of flavonoids in both cauliflower and white rice samples. For future research, it is recommended to employ water extraction methods in conjunction with higher concentrations of ethanol to enhance the recovery of bioactive compounds. Additionally, utilizing a variety of cauliflower species for testing both calorie content and microbial activity could provide more comprehensive insights into their nutritional and antimicrobial properties. This approach may lead to a better understanding of the variations in bioactive compound profiles and their potential health benefits, thereby improving the overall efficacy of the research findings.

COMPLIANCE OF ETHICAL STANDARDS

Not applicable.

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Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
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Sekian, terima kasih.

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Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar

Setuju.

27.1.2023

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