# NUTRITIONAL COMPOSITION, ANTIOXIDANT ACTIVITIES AND GLYCAEMIC PROPERTIES OF INSTANT NOODLES FORTIFIED WITH WOOD EAR MUSHROOM (*Auricularia cornea)* POWDER

**MUHAMMAD KAMIL BIN ZAKARIA**



**FACULTY OF FOOD SCIENCE AND NUTRITION**
**UNIVERSITI MALAYSIA SABAH**
**2023**

# NUTRITIONAL COMPOSITION, ANTIOXIDANT ACTIVITIES AND GLYCAEMIC PROPERTIES OF INSTANT NOODLES FORTIFIED WITH WOOD EAR MUSHROOM (*Auricularia cornea*) POWDER

**MUHAMMAD KAMIL BIN ZAKARIA**

**THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE**

**FACULTY OF FOOD SCIENCE AND NUTRITION**
**UNIVERSITI MALAYSIA SABAH**
**2023**

**UNIVERSITI MALAYSIA SABAH**

BORANG PENGESAHAN STATUS TESIS

JUDUL : **NUTRITIONAL COMPOSITION, ANTIOXIDANT ACTIVITIES AND GLYCAEMIC PROPERTIES OF INSTANT NOODLES FORTIFIED WITH WOOD EAR MUSHROOM (*Auricularia cornea*) POWDER**

IJAZAH : **SARJANA SAINS**

BIDANG : **SAINS MAKANAN**

Saya **MUHAMMAD KAMIL BIN ZAKARIA**, Sesi **2019-2023**, mengaku membenarkan tesis Sarjana ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis ini adalah hak milik Universiti Malaysia Sabah
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan ( / ):

[ ] SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA 1972)

[ ] TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

[ / ] TIDAK TERHAD

Disahkan Oleh,



**MUHAMMAD KAMIL BIN ZAKARIA**
**MI1921019T**

(Tandatangan Pustakawan)

Tarikh : 6 September 2023

(Prof. Madya Dr. Patricia Matanjun)
Penyelia Utama

# DECLARATION

I hereby declare that materials in this thesis are my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

7 June 2023

MUHAMMAD KAMIL BIN ZAKARIA
MN1921019T

# CERTIFICATION

| | |
|---|---|
| NAME | : **MUHAMMAD KAMIL BIN ZAKARIA** |
| MATRIC NUM. | : **MN1921019T** |
| TITLE | : **NUTRITIONAL COMPOSITION, ANTIOXIDANT ACTIVITIES AND GLYCAEMIC PROPERTIES OF INSTANT NOODLES FORTIFIED WITH WOOD EAR MUSHROOM (*Auricularia cornea*) POWDER** |
| DEGREE | : **MASTER OF SCIENCE** |
| FIELD | : **FOOD SCIENCE** |
| VIVA DATE | : **7 JUNE 2023** |



**CERTIFIED BY;**

Signature

**1. MAIN SUPERVISOR**
Assoc. Prof. Dr. Patricia Matanjun

**2. CO-SUPERVISOR**
Dr. Ramlah George @ Mohd. Rosli

# ACKNOWLEDGEMENTS

First and foremost, I thank Allah s.w.t for all the blessings, good health and wisdom He has always bestowed upon me throughout this research and my entire life. I would like to extend my heartfelt gratitude to all those who have supported me throughout this journey. Completing this thesis has been a truly enlightening and fulfilling experience.

The utmost gratitude to my supervisor, Assoc. Prof. Dr. Patricia Matanjun and co-supervisor, Dr. Ramlah George @ Mohd. Rosli for their unwavering support, guidance, and encouragement have been invaluable, and I am deeply grateful for their wisdom, patience, and understanding. This also includes all the committee members, for their insightful feedback and constructive criticism. Special thanks to Dr Jaya Seelan Sathiya Seelan and Ily Azzedine Alaia Bte Mh Subari for the technical support on the mushroom species identification.

I would also like to express my appreciation to Universiti Malaysia Sabah for the research fund through the niche grant scheme SDN0065-2019, Andree Alexander Funk and Phascheyllah Erdana Au from Rural Development Corporation for the supply of mushrooms and technical support, and financial support for the publication fee funding from the Research Management Centre, Universiti Malaysia Sabah.

I am grateful to my colleagues and friends, especially to Muhammad Yazid Samatra and Rabiatul Amirah Ramli who have provided me with their encouragement, support, and motivation throughout this journey. Their kindness and generosity have been truly appreciated. Finally, I would like to thank my family, who have always been my source of strength, love, and support. Their unwavering love and belief in me have been the foundation of my success.

This thesis would not have been possible without the contributions and support of each of these individuals who have helped shape this thesis into what it is today. I am grateful to have had their support and guidance, and I will forever cherish the memories of this journey.

Muhammad Kamil Bin Zakaria

7 June 2023

# ABSTRACT

The *Auricularia cornea* or also known as wood ear mushroom (WEM) is a popular edible microfungi because of its delicacy and biological activities. This study aims to determine the species, nutritional value, antioxidant activities and glycaemic effect of fortified instant noodles with WEM powder. The proximate composition, total dietary fibre (TDF), mineral analysis and antioxidant activities were conducted on the WEM powder, control and 5 % WEM instant noodles. The glycaemic analysis was conducted to evaluate the glycaemic response, glycaemic index, and glycaemic load for both instant noodles. The results revealed WEM powder consist of 48.06% carbohydrate, 37.96% crude fibre, 9.76% moisture, 7.52% protein, 2.40% ash, and 0.15% fat, while the total dietary fibre was 69.43%**.** The mineral composition of WEM powder was as follows: potassium> calcium> magnesium> sodium> iron> zinc> manganese> copper> selenium~ chromium. Next, the 5% WEM instant noodles had a significant ($p<0.05$) increased on the ash and total dietary fibre content*.* The proximate composition of 5% WEM instant noodles was 10.97% moisture, 2.87% ash, 11.39% protein, 0.16% fat, 5.67% crude fibre and 68.93 % carbohydrates while the total dietary fibre was 13.30%. The mineral composition of 5% WEM instant noodles showed there was a significant ($p<0.05$) increase in potassium, calcium, magnesium, iron, and zinc content while the content of sodium and selenium was significantly ($p<0.05$) lower than the control. The instant noodles with WEM had higher ($p<0.05$) total phenolic content (1.19 mg/mL per GAE) than the control (0.93 mg/mL per GAE). The 5% WEM instant noodles had significantly strong antioxidant activity with low $IC_{50}$ of DPPH inhibition at 13.00 mg/mL and a high value of ferric reducing power capacity, 7.64 µM $FeSO_4$/g. Moreover, the glycaemic response of 10 respondents shows the instant noodles with WEM exhibited a hypoglycaemic effect. The mean of incremental area under the curve (IAUC) of reference food was the highest at 269.83 mmol.min/L while the mean of IAUC of the test food was 196.43 mmol.min/L and 179.78 mmol.min/L for control and instant noodles with WEM respectively. There was a significant difference in the mean of IAUC between reference and test food ($p<0.05$). The glycaemic index value of the control was high (75.84) while the fortified instant noodles were medium (68.91) and both noodles have high glycaemic load. In conclusion, WEM contained nutrients like traditional food components that could be incorporated into noodles and exhibit several biological activities.

Keyword: *Auricularia cornea,* wood ear mushroom, nutrient, glycaemic response

# *ABSTRAK*


### *KOMPOSISI PEMAKANAN, AKTIVITI ANTIOKSIDAN & SIFAT GLISEMIK MI SEGERA CAMPURAN SERBUK CENDAWAN TELINGA KERA (Auricularia cornea)*

*Auricularia cornea atau turut dikenali sebagai cendawan telinga kera (WEM) merupakan kulat mikro yang popular kerana kelazatan dan aktiviti biologinya. Kajian ini bertujuan untuk mengenalpasti spesis, kandungan nutrien, aktiviti antioksidan, dan kesan glisemik mi segera campuran serbuk WEM. Analisis proksimat nutrien, jumlah serabut diet (TDF), mineral dan aktiviti antioksida telah dijalankan ke atas serbuk WEM, mi kawalan dan mi segera 5% WEM. Analsis glisemik dijalankan untuk menilai respon glisemik, glisemik indeks dan muatan glisemik bagi kedua jenis mi segera. Hasil kajian mendapati serbuk WEM mengandungi 48.06% karbohidrat, 37.96% serat kasar, 9.76% lembapan, 7.5% protein, 2.40% abu, dan 0.15% lemak, sementara nilai TDF adalah 69.43 %. Komposisi mineral serbuk WEM adalah seperti berikut: kalium> kalsium> magnesium> natrium> ferum> zink> mangan> kuprum> selenium~ kromium. Seterusnya, mi segera 5% WEM mempunyai kandungan abu dan serat diet yang meningkat dengan signifikan ($p<0.05$). Komposisi proksimat mi segera 5% WEM adalah 10.97% lembapan, 2.87% abu, 11.39% protein, 0.16% lemak, 5.67% serat kasar dan 68.93 % karbohidrat manakala TDF ialah 13.30%. Kandungan mineral bagi mi segera 5% WEM menunjukkan peningkatan yang signifikan ($p<0.05$) bagi kandungan kalium, kalsium, magnesium, ferum, dan zink manakala kandungan natrium dan selenium lebih rendah ($p<0.05$) dibandingkan dengan mi kawalan. Jumlah kandungan fenolik mi segera 5% WEM (1.19 mg/mL per GAE) adalah lebih tinggi ($p<0.05$) daripada mi kawalan (0.93 mg/mL per GAE). Manakala, aktiviti antioksidan mi campuran lebih ketara seperti nilai perencatan DPPH $IC_{50}$ yang rendah pada 13.00 mg/mL dan kapasiti kuasa penurun ferik yang tinggi, 7.64 µM $FeSO_4$/g. Seterusnya, paras glukosa darah bagi 10 responden yang memakan mi segera 5% WEM menunjukkan kesan hipoglisemik. Purata luas inkremental di bawah lengkung (IAUC) makanan rujukan adalah yang tertinggi 269.83 mmol.min/L manakala min IAUC makanan ujian ialah 196.43 mmol.min/L bagi mi kawalan dan 179.78 mmol.min/L bagi mi segera 5% WEM. Terdapat perbezaan yang ketara bagi min IAUC antara makanan rujukan dan ujian ($p<0.05$). Nilai indeks glisemik mi kawalan dalam kajian ini adalah tinggi (75.84) manakala bagi mi segera 5% WEM adalah sederhana (68.91) namun kedua-dua mi mempunyai muatan glisemik yang tinggi. Kesimpulannya, cendawan WEM mengandungi nutrien seperti kebanyakkan makanan yang boleh digunakan dalam pembangunan mi dan mempamerkan beberapa aktiviti biologi.*



*Kata kunci: Auricularia cornea, cendawan telinga kera, nutien, respon glisemik*

# LIST OF CONTENTS


| | Page |
|---|---|
| **TITLE** | i |
| **DECLARATION** | ii |
| **CERTIFICATION** | iii |
| **ACKNOWLEDGEMENTS** | iv |
| **ABSTRACT** | v |
| ***ABSTRAK*** | vi |
| **LIST OF CONTENTS** | vii |
| **LIST OF TABLES** | xi |
| **LIST OF FIGURES** | xii |
| **LIST OF EQUATIONS** | xiii |
| **LIST OF SYMBOLS** | xiv |
| **LIST OF ABBREVIATIONS** | xv |
| **LIST OF APPENDICES** | xvi |
| **CHAPTER 1: INTRODUCTION** | |
| 1.1 Background | 1 |
| 1.2 Problem Statement | 5 |
| 1.3 Research Justification | 6 |
| 1.4 Hypothesis | 7 |
| 1.5 Objectives | 7 |

**CHAPTER 2: LITERATURE REVIEW**


| | | |
|---|---|---|
| 2.1 | Instant Noodle | 9 |
| | 2.1.1 Fortification of Noodles with Mushroom | 11 |
| 2.2 | *Auricularia* spp. | 14 |
| | 2.2.1 Morphological characteristic & Taxonomy | 16 |
| | 2.2.2 Proximate Composition of *Auricularia* spp. | 19 |
| | 2.2.3 Phenolic Compound and Antioxidant Properties of WEM | 26 |
| 2.3 | Hypoglycaemic Effect of *Auricularia* Mushrooms | 27 |
| 2.4 | Concept of Glycaemic Index | 29 |
| 2.5 | Protocol of Glycaemic Analysis | 31 |
| | 2.5.1 Coefficient of Variation | 32 |
| | 2.5.2 Methodological Choices | 33 |
| | 2.5.3 Respondent Criteria | 35 |
| 2.6 | Food Factors Influencing Glycaemic Response | 37 |
| | 2.6.1 Nutrient Composition | 38 |
| | 2.6.2 Dietary Fibre | 40 |
| | 2.6.3 Non-nutrient | 41 |
| | 2.6.4 Cooking and Food Processing | 42 |
| 2.7 | Glycaemic Study of Mushrooms and Noodles | 43 |




**CHAPTER 3: MATERIALS AND METHODS**


| | | |
|---|---|---|
| 3.1 | Sample Preparation | 46 |
| 3.2 | Flow chart | 47 |
| 3.3 | Mushroom Identification | 48 |
| | 3.3.1 Morphological Character Examination | 48 |
| | 3.3.2 DNA Extraction, PCR and Sequencing | 48 |
| | 3.3.3 Phylogenetic Analysis | 49 |
| 3.4 | Proximate Composition | 49 |
| | 3.4.1 Moisture Content | 49 |

3.4.2 Ash Content 50
3.4.3 Fat Content 51
3.4.4 Protein Content 51
3.4.5 Crude Fibre 52
3.4.6 Total Carbohydrate Content 52
3.5 Total Dietary Fibre (TDF) Content 53
3.6 Mineral Analysis 54
3.7 Antioxidant Analysis 54
3.7.1 Sample Extraction 54
3.7.2 DPPH Radical Scavenging Activity 55
3.7.3 Ferric Reducing Antioxidant Power (FRAP) 55
3.7.4 Total Phenolic Content (TPC) 56
3.8 Glycaemic Analysis 57
3.8.1 Research Ethics Approval 57
3.8.2 Procedure 57
3.8.3 Calculation of Glycaemic Response, Glycaemic Index & Glycaemic Load 60
3.9 Statistical Analysis 61

**CHAPTER 4: RESULTS AND DISCUSSION**

4.1 Mushroom Identification 63
4.1.1 Morphological Characteristic 63
4.1.2 Phylogenetic Tree 66
4.2 Nutrient Composition of Wood Ear Mushroom Powder 68
4.3 Minerals Composition of Wood Ear Mushroom Powder 75
4.4 Nutrient Composition of Instant Noodles 78
4.5 Total Dietary Fibre of Instant Noodles 82
4.6 Mineral Composition of Instant Noodles 83
4.7 Antioxidant Activities and Total Phenolic Content Analysis 85
4.7.1 Mushroom Powder 85

4.7.2 Instant Noodles 88

4.8 Glycaemic Analysis 92

4.8.1 Subject Criteria & Coefficient Variation (CV) of Reference Food 92

4.8.2 Incremental Area Under the Curve of Postprandial Blood Glucose Level 93

4.8.3 Glycaemic Index & Glycaemic Load of Instant Noodles 100

**CHAPTER 5: CONCLUSION & RECOMMENDATION FOR FUTURE RESEARCH**

5.1 Conclusion 103

5.2 Suggestions for Future Research 104

**REFERENCES** 106

**APPENDICES** 128

# LIST OF TABLES

Page

Table 2.1: Taxonomy of *A. cornea* 18

Table 2.2: Proximate Composition of *Auriculariaceae* From Various Studies 20

Table 2.3: List of Macro- and Micro-Element Found in *Auricularia* spp. 25

Table 2.4: Physiological Properties of Different Types of Carbohydrates 30

Table 2.5: GI Value of Noodles from Various Research 44

Table 3.1: The Formulation of Instant Noodles in Percentage (%) 47

Table 3.2: The Randomisation of Test Food 59

Table 4.1: Proximate Composition and Total Dietary Fibre of WEM (*A. cornea*) Powder 69

Table 4.2: Mineral Composition of WEM (*A. cornea)* Powder 75

Table 4.3: Proximate Composition and Total Dietary Fibre of Instant Noodles and Commercial Wheat Flour 78

Table 4.4: Mineral Composition of Instant Noodles with and without 5% WEM 84

Table 4.5: Antioxidant Activities and Total Phenolic Content (TPC) of WEM (*A. cornea*) powder 86

Table 4.6: Antioxidant Activities and Total Phenolic Content of Instant Noodles With and Without 5% WEM Powder 89

Table 4.7: Coefficient variation within-subject of IAUC of Reference food 93

Table 4.8: Incremental Area Under the Curve (IAUC) of Test and Reference Food 96

Table 4.9: Comparison of IAUC Between Control and 5% WEM Instant Noodles 97

Table 4.10: The Glycaemic Index and Glycaemic Load of Test Food 100

# LIST OF FIGURES


| | Page |
|---|---|
| Figure 2.1: Processing of Steamed and Air-Dried/Fried Instant Noodles | 11 |
| Figure 2.2: Wild *Auricularia* spp Grows on Dead Trunk | 14 |
| Figure 2.3: The Cultivated Wood Ear Mushroom in Sabah | 16 |
| Figure 2.4: The General Anatomy of *Auricularia* spp and Examples of The Description of The Basidiomata (Fruiting Body) | 17 |
| Figure 2.5: The Flow Chart of Glycaemic Analysis | 32 |
| Figure 3.1: The Experimental Flow of Biological Properties of Wood Ear Mushroom (WEM) | 47 |
| Figure 3.2: Flowchart of Glycaemic Analysis in Every Session | 57 |
| Figure 3.3: Example of Plotted Graph to Calculate the Glycaemic Response | 61 |
| Figure 4.1: Basidiomata of *A. cornea* | 64 |
| Figure 4.2: The Phylogenetic Tree Diagram of Auricularia Species. | 67 |
| Figure 4.3: Mean comparison of postprandial blood glucose response within 120 minutes between control and fortified instant noodles (n=10) | 94 |

# LIST OF EQUATIONS


Page

Equation 3.1: Moisture Content 50

Equation 3.2: Ash Content 50

Equation 3.3: Fat Content 51

Equation 3.4: Crude Fibre Content 52

Equation 3.5: Total Carbohydrate Content 52

Equation 3.6: Total Dietary Fibre Content 53

Equation 3.7: DPPH Scavenging Activity 55

Equation 3.8: FRAP Value 56

Equation 3.9: Glycaemic Index Value 61

Equation 3.10: Glycaemic Load Value 61

# LIST OF SYMBOLS

| | | |
|---|---|---|
| **≥** | - | Equal or more than |
| **≤** | - | Equal or less than |
| **B** | - | Beta |
| **°C** | - | Degree Celsius |
| **%** | - | Percentage |

# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| **NHMS** | - | National Health & Morbidity Survey |
| **WEM** | - | wood ear mushrooms |
| **GI** | - | glycaemic index |
| **NHMS** | - | National Health and Morbidity Survey |
| ***Auricularia* spp.** | - | *Auricularia* species |
| ***A. cornea*** | - | *Auricularia cornea* |
| **KPD** | - | Rural Development Corporation (Koperasi Pembangunan Desa) |
| **IDF** | - | International Diabetes Federation |
| **IAUC/AUC** | - | incremental area under the curve/ area under the curve |
| **FAO** | - | Food & Agriculture Organization |
| **WHO** | - | World Health Organization |
| **ISO** | - | Organization for International Standards |
| **CV** | - | coefficient-variation |
| **BMI** | - | body mass index |
| **TDF** | - | total dietary fibre |
| **PCR** | - | polymerase chain reaction |
| **AOAC** | - | Association of Official Analytical Chemists |
| **ICP-OES** | - | inductively coupled plasma - optical emission spectrometry |
| **DPPH** | - | 2, 2-Diphenyl-1-picrylhydrazyl Free Radical |
| **IC50** | - | Half maximal inhibitory concentration |
| **FRAP** | - | Ferric Reducing Antioxidant Power |
| **TPC** | - | total phenolics content |
| **DW** | - | dry weight |
| **ANOVA** | - | analysis of variance |

# LIST OF APPENDICES


| | Page |
|---|---|
| Appendix A: The DNA sequences of Samples | 128 |
| Appendix B: The ITS sequences of *Auricularia* spp. derived from GenBank | 130 |
| Appendix C: Standard curve of FRAP | 133 |
| Appendix D: Standard curve of TPC | 134 |
| Appendix E: Test Food for Glycaemic Trial | 135 |
| Appendix F: Publications | 136 |
| Appendix G: Conferences, Seminar and Colloquium | 139 |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

According to International Diabetic Federation (IDF) report in 2021, 38 countries in the western pacific region that include countries in Southeast Asian, East Asian and Oceanic account for over 38% of the total number of adults livings with diabetes and are the third highest prevalence in the world at 11.9%. Additionally, countries such as China, Indonesia, Japan, Thailand, and Malaysia are among the top countries within the region that recorded the highest number of diabetes cases. Currently, it is estimated 463 million people with diabetes and without urgent and sufficient actions, the number is projected to reach 578 million in 2030 and could increase by half in 2045 (Saeedi *et al.*, 2019). This could be due to the major carbohydrate staple food in the diet and the unique phenotype, that makes Asians more susceptible to diabetes (Unnikrishnan *et al.*, 2018). Many diseases are also caused by diabetes such as premature and preventable mortality, heart disease, end-stage renal failure, blindness, stroke, and amputation which pose a major healthcare burden, especially to patients, healthcare systems, and national economies (Teo *et al.*, 2021). The same occurrence can be seen in Malaysia based on the report of the National Health and Morbidity Survey (NHMS) released every 5 years in 2019 by the Institute for Public Health Malaysia which shows a dramatic increase in diabetes cases in the last decade (NHMS, 2019). The total prevalence of overall raised blood (including people with known diabetic at 9.4% and people with raised blood glucose among unknown diabetes at 8.9%) in Malaysia is 18.9% which is an increase compared to finding in 2011 (11.2%) and 2015 (13.4%).

Previously, high consumption of fat has become the main concern in the public sphere for several non-communicable diseases but in recent years the high consumption of processed carbohydrate food or unhealthy eating habits has become the number one factor that led to increasing cases of diabetes as well as obesity at an alarming rate (NHMS,2019). Not long ago, nutrition was thought of as having only a modest influence on health, but this is not the case nowadays. Some but not all studies have associated nutrient consumption or dietary pattern with the occurrence of diabetes. Carbohydrate intake is important since it provides energy for body metabolism, but it is clear that poor dietary choice is linked to the development of hyperglycaemia and increases the prevalence of obesity and diabetes (Ismail *et al.*, 2018; Tee & Yap, 2017).

Early lifestyle interventions such as modification in dietary intake and physical activity have been suggested as effective ways for diabetes prevention (Tee & Yap, 2017). Besides the importance of consuming a balanced diet and reducing calories for better management of carbohydrate intake, the glycaemic index (GI) concept has been introduced as an additional tool in guiding food choices. The GI concept is a classification system that provides rank according to the effect on blood glucose levels which help to understand the various glycaemic response of carbohydrate foods (Jenkins *et al.*, 1981). Foods ranked with a high GI value are rapidly digested and tend to cause rapid increases in blood glucose levels, which can be problematic for people with diabetic (Augustin *et al.*, 2015). Meanwhile, a systematic review and meta-analysis published in the American Journal of Clinical Nutrition in 2019 concluded that a low GI diet is effective in improving glycaemic control and reducing the risk of cardiovascular disease in people with type 2 diabetes (Zafar *et al.*, 2019). Therefore, low GI food can control the increase of blood glucose levels after consuming carbohydrates and has been perceived as a better choice for diet (Eleazu, 2016; Giacco *et al.*, 2016).

Several factors have been identified to influence the glycaemic response of carbohydrates food such as the food processing, the nature of starch and saccharides including the presence of other food components such as fat, protein, fibre and anti-nutrients (Giacco *et al.*, 2016). Besides modifying food processing, the addition of ingredients that can lower the glycaemic response of carbohydrate-rich food has become a popular practice (Ng *et al.*, 2017; Wandee *et al.*, 2014). These food products can be categorised as a functional food as it provides health-promoting or disease-preventing beyond their traditional nutritional value (Alongi & Anese, 2021). It is important to note that the development of functional food should provide specific health benefits but not limit to the management of diabetic patients only. Other ingredients include vitamins, minerals, probiotics, antioxidants, and other functional components that could be utilised as well (Phillips & Rimmer, 2013). Thus, this has opened many potentials for other plants or novel ingredients including edible mushrooms (Khan *et al.*, 2018).

Edible mushrooms have been known as a highly nutritious ingredient with an abundance of bioactive constituents that many described as potential sources of low-calorie functional food (Lu *et al.*, 2020). For the past centuries, mushrooms have been utilised for their therapeutic effect in traditional medicine as well as it is widely used in many cuisines for their unique taste and texture (Varghese *et al.*, 2019). Advancement in cultivation methods has allowed many edible mushroom species to be cultivated worldwide without counting the species' origin (Royse *et al.*, 2017). Wood ear mushroom (WEM) or scientifically known as *Auricularia* spp*.* has come second as the most consumed and cultivated mushroom which accounts for 22.88% of the world's total output for mushroom production worldwide (Singh *et al.*, 2021). Additionally, cultivation of mushrooms in Malaysia ranked seventh as the high-value crop but 95% of its production is of *Pleurotus* spp. which could be contributed due to market demand and government policies.

In the latest trend, many have shown their interest in the health benefits of non-digestible polysaccharides of edible mushrooms, however, this novel source from edible mushrooms is still underutilized compared to conventional sources such as fruits, vegetables, and legumes (Hyde *et al.*, 2019). The presence of non-digestible polysaccharides in the human gut can reduce the spike of postprandial blood glucose levels which in turn will benefit human health (Ahmad & Khan, 2020). In addition, the abilities of the polysaccharides of WEM to exhibit the hypoglycaemic effect have been included in many scientific discussions too (Bandara *et al.*, 2019; Chen *et al.*, 2020). Past studies had demonstrated the addition of WEM into the diet would exhibit a hypoglycaemic effect in genetically diabetic mice (Kim *et al.*, 2007; Takeuchi *et al.*, 2004; Yuan *et al.*, 1998). This finding is also supported by *in vitro* study that observed the same hypoglycaemic effect of WEM conducted by Wu *et al.* (2014) and Vallée *et al.* (2017). Although there is no information related to the postprandial blood glucose response of the WEM in humans, the cited literature makes it evident that the fortification of mushrooms in staple food may improve the glycaemic control of individuals.

Instant noodles are widely accepted and highly consumed staple food, especially in the East Asia region due to the taste, affordability, and conveniences which in turn increases the risk of diet-related diseases. To address the growing demand for a healthier choice of instant noodles, the fortification of noodles by using many novels, by-products, as well as non-conventional ingredients, have become the focal point recently (Adejuwon *et al.*, 2020). In contrast, instant noodles also could be used as a tool to improve nutritional status. This is where the use of mushrooms as a functional element in instant noodles would become handy, however, the practice is relatively new (Yadav & Negi, 2021). But past studies have shown promising results on the nutrient composition and antioxidant activities of noodles fortified with mushroom powder (Arora *et al.*, 2018; Parvin *et al.*, 2020; Wahyono *et al.*, 2018).

## 1.2 Problem Statement

The knowledge related to edible mushrooms as natural health-promoting ingredients has been overwhelming and steadily growing. This however does not apply to the edible mushrooms in Sabah which are still underutilized, and lacking knowledge related to its benefits, especially for WEM that is cultivated in Sabah. The issue at hand is the uncertain classification of the WEM species being cultivated by the Rural Development Corporation of Sabah (*Korperasi Pembangunan Desa,* KPD). Although it has been identified as a member of the *Auricularia* spp. taxonomic group, the exact species remains undetermined. In addition, before consumption or utilization of WEM, it is important to accurately identify the species, as different species of mushrooms may possess different properties and efficacy. Thus, the application of molecular taxonomy and phylogenetic analysis is recommended as a means of resolving classification ambiguity.

Another issue at hand pertains to the inadequate nutrient content and unhealthiness of instant noodles. It is a widely available food product which has been perceived as an unhealthy diet due to many criticizing for the poor protein, fibre, and other micronutrients while high in carbohydrate, sodium, and fat content (Sikander *et al.*, 2017). Besides that, the high consumption of instant noodles worldwide has been associated with the lack of access to healthy and cheap food. Thus, the utilization of *A. cornea* as a functional ingredient has the potential to enhance the nutritional value of instant noodles. This mushroom has been reported to have a good source of various macro and micronutrients, making it a suitable candidate for increasing the nutritional profile of instant noodles (Ibrahim *et al.*, 2022). However, it is crucial to determine the nutrient composition and biological components of WEM before fortifying it as an ingredient in the development of functional foods. Understanding the specific biological components of WEM, including antioxidants and minerals, can assist in the formulation of functional foods that aim to provide specific health benefits.

Diabetic cases nationwide have become a concerning health issue for public health and NHMS report in 2019 suggested that unhealthy eating is one of the biggest contributors amongst the modifiable behavioural risk factors for diabetic cases (NHMS,2019). A diet that consists of high carbohydrate content can lead to hyperglycaemia and stress the pancreas in producing insulin to maintain a homeostasis level of glucose which in the long run can increase the risk of becoming a diabetic patient (Tee & Yap, 2017). As such, investigating fortified foods with low GI is crucial to assess their potential to regulate glucose control, as previous studies have demonstrated the efficacy of low GI foods in improving glucose control in individuals with diabetes. Additionally, there are no studies involving humans that observe the effect on the glycaemic response of instant noodles fortified with WEM. Therefore, there is a scarcity of information on the species, nutrient composition, antioxidant activities and *in vivo* postprandial blood glucose response of instant noodles fortified with *A. cornea* product.

## 1.3 Research Justification

The result of this study allows for a more comprehensive understanding and accurate identification of the WEM species cultivated by KPD in Sabah. Consequently, the result also will complement the limited information on nutrient content and antioxidant activities of WEM that grows in Sabah. This action will lead to greater utilization of the mushroom, which can have significant benefits in multiple industries not just limited to the development of functional food products, but also in the development of nutraceuticals and pharmaceuticals. This will promote mushroom usage and its application, leading to greater recognition and appreciation of its potential benefits. In addition, the diversification of mushroom usage can boost the local mushroom grower's economy and improve their socioeconomic status in rural areas by providing new opportunities for income generation when they tap into new markets and customer segments.