



UNIVERSITI PUTRA MALAYSIA

***SUGARCANE BAGASSE AS A POTENTIAL FUNCTIONAL INGREDIENT
IN NOODLES WITH NUTRITIONAL, FUNCTIONAL AND SENSORIAL
ACCEPTABILITY***

LAU KE QI

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ACCEPTABILITY**

By

LAU KE QI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Science**

January 2022

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the degree of Master of Science

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January 2022

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Sugarcane bagasse (SB) is one of the most abundant food wastes, mainly originating from the sugar industry, as up to 85% of SB are used as burning material. SB was reported to contain high dietary fibre and low glycemic index, which could be a potential functional ingredient. In this research, SB was incorporated into the development of noodles at three different ratios which were 5%, 10% and 15%, and noodle made without the addition of SB was used as control. In addition, a commercial noodle with similar ingredients was also used to compare with the SB incorporated noodle samples. Physical properties, proximate composition and mineral content, antioxidant properties, functional properties, dialyzable glucose and sensory score of noodles were tested to determine the suitability of SB incorporation. In terms of physical properties, 10% and 15% sugarcane bagasse incorporated noodles (SBN) had significantly ($p < 0.05$) higher score of darkness and cohesiveness as compared to control sample. The antioxidant properties of SB noodles were significantly ($p < 0.05$) increased up to 770% in DPPH assay and 244% in total phenolic compounds with 15% SB incorporation. Noodle sample with 5% SB incorporation showed the closest value with commercial noodle in terms of the functional properties. There is no significant difference in terms of water absorption index and swelling index between 5% SBN with commercial and control noodles. Total dietary fibre of noodles was significantly ($p < 0.05$) increased from 3.39% (control) to 13.85% when incorporating 15% SB. All three SBNs i.e 5, 10 and 15% noodles were qualified to be labelled as "High in dietary fibre". Sensory evaluation was also carried out to estimate the consumers' preference towards the SBN. Noodle with 5% SB incorporation had the highest overall acceptability as compared to 10% and 15% noodle and the difference was statistically significant ($p < 0.05$). As such, noodle sample with 5% SB incorporation was found to be the most suitable ratio in noodle development. In addition, noodle sample with 5% SB incorporation showed the closest value towards commercial noodles in terms of colour, texture

and functional properties, with high fibre content and antioxidant activity as well as a decent and acceptable level of overall sensory acceptability.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**HAMPAS TEBU SEBAGAI BAHAN BERFUNGSI YANG BERPOTENSI
DALAM MI DENGAN KEBOLEHTERIMAAN PEMAKANAN, FUNGSIAN DAN
SENSORIAL**

Oleh

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Hampas tebu (SB) adalah salah satu sisa makanan yang paling banyak, terutamanya berasal dari industri gula, kerana sehingga 85% daripada SB digunakan sebagai bahan pembakaran. SB dilaporkan mengandungi serat pemakanan yang tinggi dan indeks glisemik rendah, yang boleh menjadi bahan berfungsi yang berpotensi. Dalam penyelidikan ini, SB telah dimasukkan ke dalam pembangunan mi pada tiga nisbah berbeza iaitu 5%, 10% dan 15%, dan mi yang dibuat tanpa penambahan SB digunakan sebagai kawalan. Di samping itu, mi komersial dengan ramuan yang serupa juga digunakan untuk membandingkan dengan sampel mi yang disebatikan SB. Sifat fizikal, komposisi proksimat dan kandungan mineral, sifat antioksidan, sifat berfungsi, glukosa boleh dialisis dan skor deria mi telah diuji untuk menentukan kesesuaian penyebatian SB. Dari segi sifat fizikal, 10% dan 15% mi yang disebatikan dengan SB (SBN) mempunyai skor kegelapan dan kepadatan ($p < 0.05$) yang lebih tinggi secara signifikan berbanding sampel kawalan. Sifat antioksida mi SB meningkat secara signifikan ($p < 0.05$) sehingga 770% dalam ujian DPPH dan 244% dalam jumlah sebatian fenolik dengan 15% penyebatian SB. Sampel mi dengan penyebatian 5% SB menunjukkan nilai yang paling hampir dengan mi komersial dari segi sifat berfungsi. Tidak terdapat perbezaan yang signifikan dari segi indeks serapan air dan indeks mengembang antara 5% SBN dengan mi komersial dan kawalan. Jumlah serat pemakanan mi meningkat dengan signifikan ($p < 0.05$) daripada 3.39% (kawalan) kepada 13.85% apabila disebatikan dengan 15% SB. Ketiga-tiga SBN iaitu 5, 10 dan 15% mi layak untuk dilabelkan sebagai "Tinggi dalam serat makanan". Penilaian deria juga telah dijalankan untuk menganggarkan penerimaan pengguna terhadap SBN. Mi dengan penyebatian 5% SB mempunyai kebolehterimaan keseluruhan tertinggi berbanding mi 10% dan 15% dan perbezaannya adalah signifikan secara

statistik ($p < 0.05$). Oleh itu, sampel mi dengan penyebatan 5% SB didapati sebagai nisbah yang paling sesuai dalam pembangunan mi. Selain itu, sampel mi dengan penyebatan 5% SB menunjukkan nilai yang paling hampir dengan mi komersial dari segi warna, tekstur dan sifat berfungsi, dengan kandungan serat dan aktiviti antioksidan yang tinggi serta tahap penerimaan deria keseluruhan yang baik dan boleh diterima.



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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
DPPH	2,2'-diphenyl-1-piccryhydrazyl
<i>E. coli</i>	<i>Escherichia coli</i>
HCl	Hydrochloric acid
IDF	Insoluble dietary fibre
IMT	intima-media thickness
JKEUPM	Ethics Committee for Research Involving Human Subjects
LDL	Low density lipoprotein
N.D	Not Detected
OAI	Oil absorption index
SB	Sugarcane bagasse
SBN	Sugarcane bagasse incorporated noodles
SDF	Soluble dietary fibre
TDF	Total dietary fibre
TPA	Texture Profile Analysis
TPC	Total Phenolic Content
VLDL	Very low density lipoprotein
WAI	Water absorption index
XOS	Xylooligosaccharides

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Sugarcane bagasse (SB) with high dietary fibre could be a good source for partial substitution of wheat flour in noodles development. Dietary fibre has been known to have positive impact on health especially cardiovascular health. Cardiovascular disease is the first leading cause of death globally from both ischemic heart disease and stroke. It has been reported causing 15.2 million deaths in a year (WHO, 2021). As more health issues can lead to high death rates, people are getting more health conscious and more aware of the importance of a healthy diet. Indeed, consumers are willing to spend more money in order to purchase healthy food. In the study of Sangnark & Noomhorm (2004), favourable results have been shown in terms of sensory evaluation with the incorporation of SB in bread to enhance fibre content which suggested the potential of SB as a functional ingredient. As such, incorporation of SB into the development of noodles could provide more healthy food choices for consumers.

Besides having high dietary fibre, SB is also low in glycemic index (GI) (Gil-López et al., 2019). Utilizing SB as food ingredients could provide more low GI food choices in the market (Gil-López et al., 2019). Diabetes rate is increasing drastically worldwide due to the eating habits and sedentary lifestyle. The prevalence rate of diabetes in Malaysia was reported to increase from 13.4% in year 2015 to 18.3% in year 2019 which covers nearly one in five Malaysian adults (NHMS, 2021). This is mainly due to the high sugar intake by Malaysian adults from the sweet beverages and food (Amarra, Khor & Chan 2016). Low GI food choices are lacking in the market, and more low GI food should be developed to aid in controlling plasma glucose level and provide more food choices for consumers especially the diabetes patients. As such, more functional food development with high dietary fibre and low GI are deemed important.

Noodles are one of the most important staple food in many countries. Noodles were originated from China with over 4000 years of history and were further introduced to many different countries all around the world. There are different types of noodles such as wheat noodles, alkaline yellow noodles, instant noodles and rice noodles. Most of the noodles in the market are high in carbohydrates but low in dietary fibre and other nutrients such as vitamins and minerals (Chong & Aziz, 2010). China, Indonesia, India, Japan and Vietnam were reported to be the top 5 countries consuming the highest instant noodles which contributed to approximately 70,000 million servings

of noodles in 2018 (WINA 2021).. By adding nutritional value to noodles, it could benefit many consumers due to the high consumption rate globally, especially among the Asian countries.

1.2 Problem statement

Food loss and food waste are worldwide issues as they keep increasing year by year. Globally, it is reported that 1.3 billion tons of food produced have been wasted, which occupied approximately 32% of food produced annually (FAO, 2021). Food wastes worldwide are expected to increase from 2.01 billion tons to 3.40 billion tons in year 2050 according to World Bank Publications (Kaza et al., 2018). In 2016, Malaysia with more than 31 million populations, wasted 15 thousand tons of food daily (Chien Bong et al., 2016).

The food waste problem has led to many negative consequences towards the environment and economy. From the environmental perspective, food loss and waste could increase the emission of greenhouse gas (FAO, 2021). Greenhouse gases including methane, carbon dioxide and nitrogen are produced when the decomposition of food waste in landfills which then leads to the negative impacts. Approximately 4.4 gigatons of greenhouse gases are emitted due to the food waste and losses. Greenhouse gases will further contribute to climate change which will cause the rising of sea level, melting of ice and consequently lead to the extent where the earth temperature is no longer suitable for plants and animals to survive (FAO, 2021).

Food waste and losses are also contributing factors that lead to economic and resources loss. Statistically, 1.4 billion hectares of land and large amounts of water are used on harvesting food waste (FAO, 2021). The 1.3 billion tons of food waste causes land occupation footprint and water footprint. All the negative impacts are interrelated where the management of food waste is deemed important.

Sugarcane is an important crop worldwide as it is used to produce sugar. Sugarcane contains 73 to 76% of juices and the remaining fibrous matter is named as bagasse (Greenwood, 2004). There is an overwhelming source of SB globally from the sugar industry where large amounts of SB are wasted without being fully utilized. SB are wasted in a large amount not only in Malaysia, but also in many developed countries such as Brazil and Mexico in Latin America. Some SB are being discarded and some are being used as burning material or fuel (Bezerra & Ragauskas, 2016).

Besides, food sustainability is deemed increasingly important in recent years as food insecurity problems continuously increase globally. As the human population is increasing year by year, it is expected to reach 11.2 billion by the year 2100. The average population is estimated to increase 82 million people each year globally (United Nation, 2019). Resources are continuously reducing while the population is increasing annually which concerns many people. Plant-based food is known to have higher sustainability than animal-based food as some animals are facing extinction due to the climate changes (NOAA, 2014).

1.3 Significant of the study

By utilizing food waste as functional food ingredients, it can help to reduce food waste and increase food security. This study aims to develop noodles by incorporating the food waste, SB. Given the lack of utilization of SB globally, incorporating SB in functional food production can increase food sustainability and food security in the future due to the large amount of SB from the sugar industry. The findings of this study shall redound to the benefit of the environment, considering large amounts of bagasse waste could lead to environmental negative consequences.

Analysis on physical properties, chemical properties including proximate composition, mineral contents and antioxidant properties, functional properties, dialyzable glucose and sensory evaluation that were conducted in the present study on the sugarcane bagasse incorporated noodles (SBN) to explore the potential of SB as a functional food ingredient. New development utilizing SB could increase the value of SB instead of being categorized as food waste which could aid in the food insecurity problem. The development of SBN in this study could benefit the food industry by providing a possible new formulation to increase food choices of consumers.

1.4 Research Questions

1. How does incorporation of sugarcane bagasse affect the physical, chemical and functional properties of noodles?
2. Are noodles incorporated with sugarcane bagasse well accepted by consumers?

1.5 Objectives

To explore the potential of sugarcane bagasse as a functional food ingredient to be incorporated in noodles.

1.5.1 Specific Objectives

1. To determine the safety of SB for human consumption through microbiological test and heavy metal test.
2. To determine the physical, chemical and functional properties of noodles after incorporation of SB.
3. To analyse the dialyzable glucose of noodles after incorporation of SB through *in vitro* digestion experiment.
4. To analyse the acceptability of SBN by sensory evaluation.

1.6 Hypothesis

1. SB does not exceed the safety limit for both safety tests.
2. The physical, chemical and functional properties of noodles significantly improved after incorporation of SB, in comparison to control and commercial noodle.
3. The dialyzable glucose of SBN significantly decreased.
4. The acceptability towards SBN is not significantly different with control and commercial noodle.

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