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The Potential of Mushroom Seasoning as an Alternative to Monosodium Glutamate: Market Survey, Consumer Survey, and Sensory Evaluation

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HIGHLIGHTS

- Majority of consumers were aware of mushroom seasoning products available in the market and showed their willingness to try these products.
- Price and taste were the key factors influencing consumers when choosing mushroom seasoning products.
- Sensory evaluation indicated that vegetable soup containing mushroom seasoning was highly acceptable to consumers.
- Different ethnic groups (Malay, Chinese, and Indian) showed the highest level of acceptance towards different samples of mushroom seasoning.

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Abbreviations
CRS=Chinese Restaurant Syndrome
MSG=Monosodium Glutamate

ABSTRACT

Background: Mushroom presents a potential natural alternative to Monosodium Glutamate (MSG) as food flavoring, as it imparts a similar umami taste and offering health benefits when incorporated into food products. This study aimed to determine the type of mushrooms used in seasoning products in Malaysia, investigate perceptions, and evaluate sensory acceptance in vegetable soup.

Methods: A three months cross-sectional investigation was conducted in Malaysia from August to October 2023. Phase one: a market survey on online platforms and physical stores using a self-developed market survey form (n=22); Phase two: a consumer survey using an adapted survey form (n=166); Phase three: sensory evaluation of vegetable soup containing mushroom seasoning (n=51). Data was analysed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0.

Results: Twenty-two brands of mushroom seasoning products were found in the Malaysian market, predominantly containing shiitake mushrooms (*Lentinula edodes*). The majority of consumers (69.3%) were aware of mushroom seasoning products via family, peers, and electronic media. The most preferred buying platforms were supermarkets (83.7%) and grocery stores (53.0%). Key drivers for purchasing were good taste (69.3%) and replacing MSG (60.8%), while price (63.3%), have certification (61.4%), and taste (58.4%) were key priorities when choosing products. Notably, most consumers had never used mushroom seasoning (75.9%) and expressed interest in trying it (92.8%). Sensory evaluation showed a high acceptance of mushroom seasoning in vegetable soup (mean score≥5.0), with no significant difference (p>0.05) compared to MSG. Furthermore, various ethnicities demonstrated the highest level of acceptance towards different samples.

Conclusion: Mushroom seasoning is highly acceptable to Malaysian consumers and has the potential to replace MSG as a food flavoring. More scientific evidence is needed to validate the comparative flavors and benefits of mushroom seasoning as a healthier alternative, and investigations into suitable natural food flavorings should be conducted to ensure health.

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Introduction

Monosodium Glutamate (MSG) is a sodium derived from non-essential amino acid, glutamic acid, which can be found both naturally and synthetically in foods such as tomatoes, cheeses, and food additives (FDA, 2018). The crystal form of glutamic acid was first successfully extracted from seaweeds by Professor Kikunae Ikeda from University of Tokyo in 1980. Thenceforth, the term "umami" was ascertained by Professor Kikunae Ikeda to describe the taste of glutamate content and the technique for the commercial production of MSG was introduced subsequently (Campbell, 2014). Nowadays, MSG is produced through fermentation of starch, sugar beet, sugarcane, or molasses (FDA, 2018). Moreover, the toxicity of MSG was first suspected by a researcher when several symptoms, such as numbness in various body areas, lethargy, and tachycardia, appeared after dining at a Chinese restaurant. The use of MSG in soy sauce, which is widely used in Chinese cuisine, was believed to contribute to these complex symptoms, which were then termed Chinese Restaurant Syndrome (CRS) or MSG complex symptoms (Campbell, 2014). Soon afterwards, various research including chronic feeding research, surveys, both animal and human research were carried out to investigate and reveal the cause of CRS. Although MSG is said to have the potential to enhance food flavor while simultaneously reducing sodium intake, research on its side effects and health complications is ongoing. For example, a review from Niaz et al. (2018) concluded that MSG usage can increase the risk of obesity, CRS, neurotoxic effect, and affect normal reproductive systems. Preclinical research also demonstrated that MSG can lead to various side effects affecting the cardiovascular system and central nervous system (Zanfirescu et al., 2019). Nevertheless, MSG is classified as Generally Recognised as Safe (GRAS) by the Food and Drug Administration (FDA), and its usage of MSG is not prohibited in Malaysia (FDA, 2018). This was because positive CRS symptoms associated with MSG consumption were only adduced in research involving animal subjects but consistent stimulation of CRS symptoms has not been successfully replicated in human subjects (Niaz et al., 2018). However, it is advised that the prohibition of MSG should be reconsidered if stronger scientific evidence indicated a positive relationship between MSG and CRS (Niaz et al., 2018). It is also strongly recommended to enact specific regulations to ensure the consumers' health and safety by limiting the amount of MSG usage in food or replacing it with natural and healthier alternatives (Jayabalan and Randawar, 2020).

Due to the intention of enhancing product flavor, significant amounts of MSG were added to some commercial products in the market as food additives, including Ready-to-Eat (RTE) products like sauces, stock cubes, and soups, which are detrimental to consumer's health (Yu et al., 2023) In fact, MSG can be found naturally in foods like cheese, tomatoes, and edible mushrooms. (Naveen Kumar et al., 2020). Edible mushroom have been referred to as "Food of the Gods" by our ancestors due to their health benefits and sensory qualities. Furthermore, several studies have proved mushrooms to be effective in reducing the risk of hypertension, cerebrovascular accident (stroke), cancer, and other health complications. The functional properties of mushrooms are attributed to a bioactive compound known as β-glucans, which can strengthen innate and cell-mediated immune responses (Valverde et al., 2015). Hence, manufacturers add mushroom powder to food products for nutrient enrichment purposes. This can be illustrated by the addition of mushroom powder to biscuits and corn starch products to improve quality and protein content, respectively (Bulam et al., 2022).

In addition to their health benefits, mushrooms also positively affect consumers in term of sensory attributes. Several studies have reported that the unique aroma of mushrooms is attributed to ketone and ester compounds (Sun et al., 2020), while the umami taste is related to similar protein content, specifically aspartate (Asp), and glutamate (Glu), found in MSG (Ang and Ismail-Fitry, 2019). Several studies have been conducted to produce alternatives to MSG. Wang et al. (2019) proposed a study to compare the usage of MSG and mushroom extract using chicken broth as the medium. This study proclaimed that mushroom extract has the potential to replace MSG in the same ratio by showing a synergistic effect. The aroma and umami taste of edible mushroom can be the focus for future research aimed at exploring alternatives to MSG (Sun et al., 2020). In conjunction with the potential of mushrooms to replace MSG as natural food flavoring, this study aimed to survey the type of mushrooms used in mushroom seasoning products in Malaysia, investigate consumers' awareness level, frequency of usage, perceptions regarding mushroom seasoning, and determine acceptance level of mushroom seasoning as an MSG alternative among consumers.

Materials and methods

Study design

This is a cross-sectional study consisting of three components: a market survey on mushroom seasoning products available in Malaysia (n=22), a consumer survey assessing the level of awareness and perceptions regarding them (n=166), and a sensory evaluation of vegetable soup containing mushroom seasoning (n=51). The market

survey for mushroom seasoning products was conducted on online platforms and in physical stores in Kuala Lumpur. The consumer survey questionnaire was distributed both physically and through online social media platforms, whereas the sensory evaluation was carried out at the Sensory Lab located on Block C, level one, Faculty of Health Sciences, Universiti Kebangsaan Malaysia.

Subject recruitment

For the market survey, a random sampling method was used to assess the brands of mushroom seasoning available in the Malaysian market. Physical stores in Kuala Lumpur and online platforms were selected randomly and data on the products were recorded. For the consumers survey, a total of 166 subjects who met the recruitment criteria: 1) adults aged 18 years and above, 2) Malaysian citizen, 3) able to read and understand Malay language, were recruited by spreading the questionnaire via social media platforms and in person with printed questionnaires. Informed consent was included with the questionnaire, which was presented to subjects to obtain their agreement prior to completing it. Additionally, a total of 51 subjects were recruited for sensory evaluation using a purposive sampling method. All subjects were recruited at University Kebangsaan Malaysia, including students and staff, based on recruitment criteria, and ensuring proportional representation across difference ethnicities (Malay, Chinese, and Indian/Others). A consent form was provided, and an agreement form was signed by each subject during the recruitment process. Data collection was carried out from August to October 2023 after receiving approval from the Research Ethics Committee of University Kebangsaan Malaysia (JEP-2023-479).

Equipment and instruments

Market survey form was developed by the authors to collect data. Information collected included brand, source, price per 100 g, country of origin, MSG content, type, position of mushroom in the ingredients list, and sodium content per serving. For the consumer survey, participants filled out the questionnaire using Google forms. The questionnaire was adapted from a previous study by Mat Amin et al. (2017), and pilot-testing was conducted to examine its reliability. Cronbach's alpha was calculated, yielding the value of 0.705 indicating high internal consistency for the adapted questionnaire. Additionally, a seven-point hedonic scale sensory form was given to subjects during the sensory evaluation. The vegetable soup was prepared in dietetics laboratory at Block C, Level one, Faculty of Health Sciences University Kebangsaan Malaysia. The ingredients used to prepare vegetable soup included drinking water, potatoes, yellow onions, carrots, celery, garlic cloves, bay leaves, black peppers, and parsley. All ingredients were cooked in a closed pot for one h over low heat and then filtered.

Prior to serving the samples to subjects, the vegetable soup was heated and seasoned with salt (1/250 g/ml) along with a specific ratio of MSG (Ajinomoto, Malaysia) and mushroom seasoning (Love Earth, Malaysia), at one g per 250 ml. The selected brand of mushroom seasoning was the most common brand identified in the market survey conducted. Each sample was labelled with a different three-digit code, [S=salt; MP=mushroom seasoning powder] control sample 077 (S), 114 (S+100% MSG), 521 (S+50% MSG+50% MP), 527 (S+100% MP), and 983 (100% MP) in two-ounce transparent containers with lids. Notably, the total amount of MSG in all samples did not exceed the FDA recommendation of three g (FDA, 2018). Based on food labelling, the similarity in sodium content between MSG and mushroom seasoning (125 and 128 mg/g, respectively) ensured that differences in sodium levels did not affect the accuracy of the results. To standardize the sensory evaluation process, drinking water was served as a palate cleanser prior to tasting each sample. Subjects were required to evaluate each sample based on appearance, aroma, color, salty taste, umami taste, and overall acceptance. A seven-point scale was used, where a score of one indicated extreme dislike and a score of seven indicated extreme likeness. Prior to tasting the samples, subjects were instructed to observe and smell each sample before assigning their scores. To maintain objectivity, discussion among subjects were strictly prohibited.

Statistics analysis

IBM Statistical Package for the Social Sciences (SPSS) version 26.0 was used to analyse the data. Descriptive analysis was used to present the data collected from the market survey and consumer survey, while one-way analysis of variance (ANOVA) was employed to analyse the data from sensory evaluations, performing post hoc test Tukey's HSD to determine differences between mean scores of the samples. The *p*-value less than 0.05 was considered statistically significant.

Results and discussions

Market survey

The market survey on mushroom seasoning products was conducted through online platforms and physical stores in Kuala Lumpur. Table 1 shows the detailed information about mushroom seasoning products, including product brand, source, price per 100 g, country of origin, MSG content, type, sequencing of mushrooms in the product ingredient list, and sodium content per serving. A total of 22 different brands of mushroom seasoning products were

identified in the market survey. The most common brand available in the Malaysia market was L.E., which could be found on both online platforms and in physical stores. All products could be purchased through online platforms, while only 27.3% of the products were available in physical stores. Moreover, most brands surveyed in this study were local products (54.5%).

According to the ingredient labelling, 22.7% of products contained MSG. Shiitake mushroom was the most commonly used type in mushroom seasoning production with 54.5% of products containing it (*Lentinula edodes*); followed by king oyster mushroom (*Pleurotus eryngii*) (13.6%), monkey head mushroom (*Hericium erinaceus*) and matsutake mushroom (*Tricholoma matsutake*) (9.1%), button mushroom (*Agaricus bisporus*), and straw mushroom (*Volvariella volvacea*) (4.5%). The common use of shiitake mushroom in mushroom seasoning can be attributed to their unique and favourable taste, making them highly acceptable and preferred by consumers worldwide (Hou et al., 2021). These findings align with those of Manjit et al. (2021), who concluded that shiitake mushrooms are among the major varieties in the 21st century, accounting for the highest global production of mushrooms, while straw mushrooms contributed the least.

The average sodium content of mushroom seasoning products (n=21) in the Malaysian market surveyed in this study was 129.35 mg/g. However, the data on mushroom seasoning products was not fully accomplished, as this study found that one product did not label its sodium content and six products did not specify the type of mushroom used. Moreover, errors in sodium content were also identified in product brand M, which contained salt as an ingredient but claimed to have no sodium content in the nutrition information panel. These blatant oversights in food labelling indicate gaps and delays in the policy implementation process. This may be attributed various barriers including a lack of resources and monitoring, as well as industry resistances like lobbying (Ng et al., 2021).

Consumer survey

Table 2 shows the socio-demographic characteristics of the consumer survey subjects. A total of 166 subjects participated in this consumer survey. Most participants were young consumers aged between 18 and 24 years old (66.3%).

Table 1: Market survey results

No.	Brand initials	Platform		Price per 100 g (RM)	Country of origin	MSG Content	Type and position of mushroom in ingredients list	Sodium content per serving (mg/g)
		Physical store	Online					
1.	L.E.	✔	✔	13.27	Malaysia	No	Shiitake (first) (40%)	130
2.	E.L.	✔	✔	11.75	Singapore	No	Shiitake (first)	238
3.	O.P.	✔	✔	13.00	Malaysia	No	Shiitake (first)	10
4.	M.F.	✔	✔	14.33	China	No	Hericium (first)	177
5.	M-M	✔	✔	8.83	Malaysia	No	Not listed (first)	1.2
6.	C.E.	✔	✔	12.33	Malaysia	No	Hericium (first)	7.8
7.	M	✖	✔	5.11	Indonesia	No	Not listed (first)	0
8.	E	✖	✔	5.26	Malaysia	No	Shiitake (first)	238
9.	A	✖	✔	15.00	Malaysia	No	Shiitake (first)	-
10.	R	✖	✔	8.65	Singapore	No	Shiitake (first)	130
11.	B	✖	✔	11.20	Singapore	No	Shiitake (first)	127
12.	VC	✖	✔	12.80	Taiwan	Yes	King oyster, Button (first)	137.5
13.	V.T.	✖	✔	5.70	Singapore	No	Shiitake (first)	130
14.	O	✖	✔	8.20	Malaysia	No	Not listed (first)	1.8
15.	DC	✖	✔	11.27	Malaysia	Yes	Shiitake (second)	194.45
16.	E	✖	✔	7.52	Malaysia	No	Not listed (second)	120
17.	L	✖	✔	9.47	Taiwan	No	Shiitake (second)	166.35
18.	S.X.X.	✖	✔	14.50	China	No	Matsutake, Shiitake, Straw, King Oyster (second)	156.00
19.	P	✖	✔	6.58	Malaysia	Yes	Not listed (third)	160
20.	J.J.	✖	✔	5.47	Malaysia	No	Not listed (third) (12%)	155.75
21.	G	✖	✔	8.82	China	Yes	Pleurotus eryngii, Matsutake (third)	225.58
22.	V	✖	✔	3.45	Malaysia	Yes	Shiitake (sixth)	210

MSG=Monosodium Glutamate; RM=Malaysian Ringgit

Table 2: Socio-demographic characteristics of consumer survey participants (n=166)

Consumer profile	n (%)
Age	
18-24 years old	110 (66.3)
25-34 years old	29 (17.5)
35-44 years old	18 (10.8)
45-54 years old	7 (4.2)
55 years old and above	2 (1.2)
Gender	
Male	38 (22.9)
Female	128 (77.1)
Ethnicity	
Malay	69 (41.6)
Chinese	80 (48.2)
India	17 (10.2)
Educational level	
Primary school	-
Secondary school	25 (15.1)
College/university	141 (84.9)
Employment status	
Public sector	14 (8.4)
Private sector	36 (21.7)
Self-employed	11 (6.6)
Unemployed/student	104 (62.7)
Others	1 (0.6)
Individual income	
No income	109 (65.7)
≤RM 1,500	7 (4.3)
RM 1,501-RM 3,000	17 (10.2)
RM 3,001-RM 4,500	16 (9.6)
RM 4,500-RM 6,000	6 (3.6)
>RM 6,000	11(6.6)

Consumers' awareness level towards mushroom seasoning and information sources

Table 3 presents the level of awareness among consumers regarding the presence of mushroom seasoning products in the Malaysian market. Most subjects (69.3%) were aware of mushroom seasoning products, whereas only 30.7% were not. Additionally, the result of the study revealed that most subjects identified their family members or friends (57.4%) and electronic media (53.0%) as their primary sources of information. Furthermore, based on the result of the consumer survey, the level of awareness among Malaysian consumers regarding mushroom seasoning products have increased compared to the previous similar studies (Mat Amin et al., 2017). This increase in awareness is attributed to the growing trend of mushroom-based products in food industry and the increasing demand for natural food products (Veljović and Krstić, 2020).

Frequency of using the mushroom seasoning

Although the level of awareness regarding mushroom seasoning products was shown to be high in this study, results presented in Table 3 illustrated that most subjects never use mushroom seasoning products (75.9%), followed by those who use them once or twice per week (16.3%), every day (4.2%), three to four times a week (3.0%), and five to six times per week (0.6%). The low frequency of using mushroom seasoning could be due to insufficient scientific validation regarding the nutritional benefits of mushrooms. This information was of utmost importance to build confidence among consumers in purchasing mushroom-based products including mushroom seasoning (Veljović and Krstić, 2020). This finding also supports a previous study from Mat Amin et al. (2017), which found that monthly expenses for mushroom-based products among Malaysian consumers were very low, with less than RM50 spent per month, categorizing it as the lowest expenses category, indicating that consumption practices of mushroom-based products among Malaysian consumers were unsatisfactory (Lim et al., 2023).

Consumers' perception towards mushroom seasoning

This study collected consumers' opinions on the dissemination of information related to benefits of mushroom seasoning products in Malaysia, preferred buying platforms, purchase drivers, and priorities when choosing mushroom seasoning products. According to Table 3, most subjects (64.5%) found that information regarding the benefits of mushroom seasoning products was not widely disseminated. This was attributed to a lack of effective and persistent promotional strategies by mushroom producers and mediums (Shwetha et al., 2021). Therefore, various marketing strategies through different channels should be emphasized to deliver the nutritional properties of mushrooms (Bringye et al., 2021; Shwetha et al., 2021). Furthermore, implementing claims about the benefits of mushrooms on food labelling is also suggested (Bou Fakhreddine and Sánchez, 2023). In relation to information sources, this study found that friends or family members were the primary sources of mushroom seasoning information. Similarly to the statistics of the Marketing Chart website, friends or relatives were also rated as the most trusted sources to obtain any information about a product or service. Electronic media was also identified as one of the main information sources supporting previous findings by Mat Amin et al. (2017) related to mushroom-based products. This can be explained by the widespread use of electronic media by companies worldwide to launch and market new products or services due to its low marketing costs and advantages in connecting consumers with the relevant product information (Chalfoun and Davidavičienė, 2017); therefore, being the easiest method to achieve any information (Predanócyová et al., 2023)

Supermarkets (83.7%) and grocery stores (53.0%) were identified as the most preferred purchasing platforms for mushroom-based products in Malaysia, with supermarkets serving as the main marketing channel (Mat Amin et al., 2017). Other studies have also confirmed that supermarkets are favoured by consumers for mushroom-based products (Ganeshkumar et al., 2020; Predanócyová et al., 2023).

Based on the results in Table 3, good taste (69.3%) was chosen as the main driving factor for purchasing mushroom seasoning products (Jung et al., 2020). Furthermore, taste was identified as the primary attribute that characterizes the nutritional properties of a product and could affect consumers' food choices (Ballesteros et al., 2021). Another main driving factor was identified as the desire to replace MSG (60.8%). This is due to the growing health awareness and demand for products without added MSG among Malaysian consumers (Radam et al., 2010). Consequently, negative perceptions of MSG-containing products have led to relatively low purchase and usage rates in Malaysia (Rajiah et al., 2020).

Table 3: Consumer survey results

Results	n (%)
Level of awareness	
Aware	115 (69.3)
Not aware	51 (30.7)
Information sources	
Friends or family members	66 (57.4)
Electronic media	61 (53.0)
Print media	19 (16.5)
Seminar and exhibition	14 (12.2)
Others	7 (6.1)
Frequency of mushroom seasoning usage	
Never	126 (75.9)
1-2 times a week	27 (16.3)
Everyday	5 (3.0)
3-4 times a week	1 (0.6)
5-6 times a week	7 (4.2)
Consumer's perceptions of the dissemination of information related to health benefits of mushroom seasoning	
Yes	59 (35.5)
No	107 (64.5)
Buying platform	
Supermarket	139 (83.7)
Convenience store	88 (53.0)
Online platform	63 (38.0)
Medical store/pharmacy	21 (12.7)
Exhibition	12 (7.2)
Direct sales	11 (6.6)
Others	2 (1.2)
Driving factors influencing the purchase of mushroom seasoning products	
Good taste	115 (69.3)
Replace the usage of Monosodium Glutamate (MSG)	101 (60.8)
Reasonable price	62 (37.3)
Scientific evidence regarding the benefits of mushroom seasoning	58 (34.9)
Personal preference for mushrooms	54 (32.5)
Friends/relatives' influence	52 (31.3)
Advertisement/promotion	46 (27.7)
Attractive packaging	15 (9.0)
Priorities when choosing mushroom seasoning products	
Price	105 (63.3)
Certifications	102 (61.4)
Taste	97 (58.4)
Authenticity	82 (49.4)
Brand	46 (27.7)
Packaging	21 (12.7)
Others	1 (0.6)
Desire to try mushroom seasoning	
Yes	154 (92.8)
No	12 (7.2)

The main priorities for consumers when choosing mushroom seasoning products based on product attributes were identified as price (63.3%), certification (61.4%), and taste (58.4%). Reasonable prices can contribute to higher consumer satisfaction levels (Zhao et al., 2021), while high prices always present barrier to purchasing mushroom-based products (Veljović and Krstić, 2020). Since Muslims constitute a significant portion of Malaysia's population, products with halal certification were preferred by Malaysian consumers (Shamri et al., 2021). Taste remained the main factor influencing consumer decisions since it often motivated mushroom-based products purchases (Predanócyová et al., 2023; Shah, 2021). The results also showed that a majority of consumers expressed a desire to try mushroom seasoning, likely due to a shift in preferences toward mushrooms rich in umami compounds and negative perceptions of MSG (Harada-Padermo et al., 2021).

Sensory evaluation of vegetable soups containing MP and MSG

Six attributes, comprising appearance, aroma, color, salty taste, umami taste, and overall acceptance, were evaluated and the average scores of samples are presented in Table 4. Regarding the overall acceptance, the sensory results indicated that sample two (5.33±1.24), sample three (5.29±1.19), and sample four (5.00±1.43) were highly acceptable to subjects with mean scores≥5.0. In addition, post hoc Tukey's HSD test was conducted to compare the mean scores between samples (appearance: p=0.175; aroma: p=0.089; color: p=0.101; salty taste: p<0.001; umami taste: p<0.001; overall acceptance: p<0.001). No significant differences (p>0.05) were found between the mean scores for attributes of appearance, aroma, and color. This indicates that there is no significant difference (p>0.05) regarding the ability of MP to replace MSG. This can be explained by the MSG-like umami compounds present in mushrooms, which contribute to a similar effect as MSG in enhancing food palatability when used as a flavor enhancer (Harada-Padermo et al., 2021). These results also show the suitability of fortifying vegetable soup with mushroom powder, as it did not negatively affect the sensory attributes and was well accepted by consumers. In contrast, the darker color contributed by mushroom in biscuit fortification was shown to negatively impact the likeness level among consumers (Proserpio et al., 2019).

In relation to salty taste, umami taste, and overall acceptance, there was a significant (p<0.05) lower mean score in sample one (S) and sample five (100% MP). This can be attributed to the advantages of flavor enhancers that can positively affect the food attributes and increase the level of acceptance and likeness among consumers by providing umami taste (Miyaki et al., 2015). In addition, reducing salt negatively impacted the overall taste of the food significantly, leading to lower acceptance levels. This is because salt enhanced palatability by suppressing bitterness in food (Kongstad and Giacolone, 2020; Nurmilah et al., 2022).

Table 4: Mean scores from sensory evaluation of various vegetable soup samples containing different amount of Monosodium Glutamate (MSG) and mushroom seasoning powder

Attributes	Sample 1 (S)	Sample 2 (S+100% MSG)	Sample 3 (S+50% MSG+50% MP)	Sample 4 (S+100% MP)	Sample 5 (100% MP)
Appearance	4.20±1.18 [a]	4.37±1.06 [a]	4.65±1.13 [a]	4.63±1.26 [a]	4.24±1.35 [a]
Aroma	5.33±1.01 [a]	4.78±1.24 [a]	5.06±1.29 [a]	5.04±1.06 [a]	4.71±1.55 [a]
Color	4.08±1.21 [a]	4.37±1.13 [a]	4.63±1.23 [a]	4.51±1.19 [a]	4.14±1.23 [a]
Salty taste	3.53±1.39 [a]	4.90±1.15 [b]	5.06±1.26 [b]	4.67±1.51 [b]	3.18±1.53 [a]
Umami taste	3.65±1.59 [a]	4.84±1.30 [b]	5.18±1.47 [b]	4.75±1.74 [b]	3.45±1.64 [a]
Overall acceptance	4.06±1.41 [a]	5.33±1.24 [b]	5.29±1.19 [b]	5.00±1.43 [b]	3.63±1.54 [a]

Different superscripts in the same row indicate significant differences (p<0.05). Post Hoc Tukey's HSD test was performed to compare mean scores.
Results are reported in Mean±Standard Deviation (SD)
MP=Mushroom seasoning Powder; S=Salt

Comparison between mean scores of overall acceptance among different ethnicities

Table 5 shows the mean scores for overall acceptance of different vegetable soup samples containing varying amounts of MSG and MP among different ethnicities. Different ethnicities exhibited the highest overall acceptance towards specific samples. Sample four (S+100% MP) for Malay, sample three (S+50% MSG+50% MP) for Chinese and sample two (S+100% MSG) for Indian. However, there was no significant differences (p>0.05) between soup containing mushroom seasoning and those containing MSG for each ethnic group. This could be explained by the fact that differences in ethnicity have attributed to different taste perceptions and responses (Williams et al., 2016). Moreover, Indians showed the highest level of acceptance for samples containing MSG probably due to a lesser preference for mushroom flavor among Indians compared to Malays and Chinese participants (Rosmiza and Juliana, 2017). Additionally, the differences in family traditions and ingredient utilisation were also identified as important drivers influencing mushroom consumption (De Cianni et al., 2023).

Table 5: Mean score for overall acceptance of various vegetable soup samples containing different amount of Monosodium Glutamate (MSG) and mushroom seasoning powder among different ethnicities

Ethnicity	Sample 1 (S)	Sample 2 (S+100% MSG)	Sample 3 (S+50% MSG+50% MP)	Sample 4 (S+ 100% MP)	Sample 5 (100% MP)
Malay	3.35±1.45 [a]	5.12±1.50 [b]	5.18±1.29 [b]	5.41±1.28 [b]	3.59±1.62 [a]
Chinese	4.47±1.42 [ab]	5.41±1.12 [a]	5.59±1.12 [a]	5.06±1.48 [ab]	3.88±1.32 [b]
India and others	4.35±1.11 [ab]	5.47±1.12 [a]	5.12±1.17 [a]	4.53±1.46 [ab]	3.41±1.70 [b]

Different superscripts in the same row indicate significant differences (p<0.05). Post Hoc Tukey's HSD test was performed to compare mean scores. Results are reported in Mean±Standard Deviation (SD).
MP=Mushroom seasoning Powder; S=Salt

Conclusion

A total of 22 brands of mushroom seasoning were identified in the Malaysian market with Shiitake mushroom (*L. edodes*) being the most commonly used type. Some products were found to be non-compliant with labelling requirements in Malaysia, where disclosing sodium content and applying Quantitative Ingredient Declaration (QUID) will become mandatory for all products starting in 2024.

The results show a high level of awareness regarding mushroom seasoning products among Malaysian consumers, despite a low frequency of usage. Good taste and the desire to replace MSG emerged as the primary driving factors behind the purchase of these products. In Addition, price, certification, and taste were identified as key priorities for consumers.

Sensory evaluation revealed that vegetable soup with added mushroom seasoning as an MSG alternative was highly acceptable by consumers, achieving a mean score≥5.0. In terms of salty and umami taste, mushroom seasoning produced effects similar to those of MSG (p>0.05). Conversely, samples without seasonings and those with reduced salt content were significantly (p<0.05) less acceptable (mean score<5.0) by consumers. Different ethnicities exhibited the highest mean score for overall acceptance towards various samples. However, no significant differences (p>0.05) were observed between MSG and mushroom seasoning.

This study had some limitations. The majority of subjects involved in the consumer survey and sensory evaluation were young consumers from a single faculty, which may not represent the preference of all age groups in the market. Despite these limitations, the findings provide valuable insights for future research, including data from market surveys and consumers perceptions regarding mushroom seasoning products.

Author contributions

H.H. the principal investigator, conceptualised, designed, and supervised the study, advised on data analysis, and interpretation, prepared the draft manuscript and reviewed it; W.T.L. conducted the study, collected data, performed data analysis and interpretation, assisted in drafting the manuscript and reviewed it. Both authors read and approved the final manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

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Ethical consideration

This study was approved by the UKM Research Ethics Committee with the code JEP-2023-479.

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