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Application of Natural Ingredient Sources as an Enhancer For Umami Flavor and Its Use in Food Products

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ABSTRACT: Food additives and flavor enhancers are extensively utilized within the food industry to augment palatability and overall consumer appeal, thereby meeting market demands. Among these enhancers, Monosodium glutamate is prevalent, particularly in savory and vegetarian products, for its ability to intensify taste and confer a rich, savory flavor reminiscent of meat. However, its consumption at elevated levels has been associated with numerous adverse effects. Conversely, umami, which is found naturally in foods like hydrolyzed plant protein, yeast extracts, derivatives of soy, and particular vegetables and dairy products, provides a healthier substitute for chemical flavor enhancers.

This study endeavored to formulate a food product featuring natural umami constituents. Yeast extract and mushroom powder were selected as key umami ingredients, renowned for imparting a meaty essence to culinary creations. A dehydrated soup premix was developed, comprising three variations: Sample A serving as control, Sample B and Sample C including shiitake mushroom powder and yeast extract (1%) in each sample. Chemical analysis and nutritional composition of the samples were analyzed along with the sensory evaluation and shelf-life studies. Results revealed that moisture levels fell within FSSAI specifications (2.7% to 3.7%). Notably, the soup premix was devoid of preservatives. Sample C garnered greater acceptability among panelists compared to Samples A and B. Results also showed that addition of even 1% of the umami substitutes imparted meaty flavor in the soup premix hence showing an acceptable alternative to MSG.

Keywords - Food additives, umami flavour, yeast extract, mushroom powder**.**

Introduction

Food additives and flavor enhancers are extensively used in the food industry to increase the palatability and broader acceptance of the food product and fulfill the consumer's demand. Amongst the flavor enhancers, Monosodium glutamate is widely used in different products especially the savory and vegetarian products to enhance taste and give the food a meaty and savory enhanced flavor. The word "UMAMI" in Japanese is brothy, meaty or savory flavor that comes from fish and meat and as a taste that was first scientifically defined and coined by Kikunae Ikeda in 1908. Umami is described as a "pleasure" and has been recognized as aromatic, regardless of being often odorless (Diepeveen *et al*., 2022) [1] and is classified as the fifth fundamental taste while the other four basic tastes being sweet, sour, bitter and salty. Major umami components include glutamic acid (Glu), aspartic acid (Asp), and amino acids that resemble monosodium glutamate (MSG). Later, several umami flavor compounds like purine ribonucleotides were identified as the primary umami ingredient together with 5′-inosine monophosphate (IMP), 5′-guanosine monophosphate (GMP), and 5′-adenosine monophosphate (AMP) (Gao *et al*., 2021) [2]. Umami nucleotides like Foods that have been fermented are particularly high in both free glutamic acid and unbound nucleotides (Schmidt and Mouritsen, 2022) [3]. Umami flavor is found to be present in ingredients such as hydrolyzed plant protein, hydrolyzed yeast, yeast extract, extracts of soy, and isolates of protein as well as in tomatoes, seaweeds and fromages. The table 1 below shows the amount of Umami components present in the food ingredients other than seaweeds and tomatoes given by the Umami Information Centre which is the Umami Database for various food products and ingredients (Umami Database, Umami Information Center). Over 14,000 mushroom varieties have been recognized, with approximately 2,000 deemed suitable for consumption or medicinal purposes (Lu *et al*., 2020; Wang *et al*., 2019) [4,16]. Commonly encountered mushroom species thriving in favorable ecological conditions include *Auricularia auricula* (wood ear), *Ganoderma* (Reishi), *Grifola frondosa* (maitake), *Tremella* (white jelly), *Lentinula edodes* (shiitake), *Agaricus spp*. (champignon), and *Pleurotus spp.* (oyster) ((Lu *et al*., 2020) [4]. A paper (Gao *et al*., 2021) [2] suggested that 5′-mononucleotides, including 5′-guanylic acid (5′-GMP), 5′-inosinic acid (5′-IMP), 5'-xanthylic acid (5′-XMP), and 5′-adenylic acid (5′-AMP), along with amino acids resembling monosodium glutamate (MSG) such as Asp and Glu, aid to enhancing the savory flavor of mushrooms. Studies reveal that *O. radicata* and *P. eryngii,* both the edible fungi varieties, exhibit the highest level of umami taste (Zhao *et al*., 2023; Niaz *et al*., 2018) [5,14]. Yeast extracts, initially recognized and utilized mainly for their nutritional and flavor-enhancing qualities in food, are increasingly employed as functional ingredients in both functional foods and dietary supplements. Within these yeast extracts, substantial quantities of glutamic acid, nucleoside monophosphate, along with an array of amino acids and proteins, collaborate cooperatively to enhance the taste of foods (Alim *et al*., 2019) [6]. Widely utilized in sauces, meat products, fermented meals, and low-salt formulations, yeast extract is valued for its impressive light-salt umami-enhancing effect (Wang *et al* 2023) [7]. Glutamate is present inherently in foods such as meat, tomatoes, and human mammary milk, serving as a source of energy and a precursor for various amino acids and glutathione in the human body. While glutamate exists in both free and bound forms in nature, only the free forms contribute significantly to flavor enhancement (Wang and Adhikari, 2018) [8]. Designated as INS 621, monosodium glutamate is extensively utilized as a flavor enhancer. According to FSSAI, the maximum permissible limits for MSG are set at 500 mg/kg in canned crab meat, and its addition to specific foods is regulated under Good Manufacturing Practices (GMP) levels (FSSAI, 2020) [9]. Despite its widespread use, concerns have been raised about potential adverse effects on human health associated with excessive MSG consumption. Adverse physiological impacts on the brain, reproductive system, cardiovascular system, immune system, and an elevated risk of obesity and metabolic diseases have been linked to MSG overuse (Mahajan *et al*., 2023) [10]. Research found that MSG intake disrupts leptin-mediated hypothalamic signaling and increases food palatability, potentially contributing to obesity by upsetting energy balance (Wijayasekara and Wansapala, 2021) [11]. Extensive studies, particularly in mouse and animal models, indicate that male rats given MSG exhibit decrease in high-density lipoprotein (HDL) profiles and elevated levels of body mass index, triacylglycerol, cholesterol, glucose, insulin, and leptin (Wijayasekara and Wansapala, 2021) [11]. Increased MSG intake has also been associated with "Chinese Restaurant Syndrome," characterized by symptoms like palpitations, numbness, and face pressure 15 to 20 minutes after dining at a Chinese restaurant (Poojary *et al.*, 2017) [15]. While these symptoms are transient, there is controversy surrounding whether higher MSG ingestion is the cause (Hajihasani *et al*., 2020; Morelli *et al*., 2013) [12,13].

Table 1: Amount of umami components

Description	Food Group	IMP (mg)	GMP (mg)	AMP (mg)	Glu (mg)	Asp (mg)	Note
Fresh shiitake mushroom	Mushroom	0	0		71	8	Levels of naturally occurring glutamate ~70 (mg/100g) EUC
Dried shiitake mushroom	Mushroom	0	150		1060	70	Levels of naturally occurring glutamate ~1060 (mg/100g) EUC
Dried tomato (Japan) [13]	Vegetables	-	-	-	648	320	Value as per (mg/100g) EUC
Garlic (Japan)	Vegetables	-	-	-	99	90	Levels of naturally occurring glutamate ~100 (mg/100g) EUC
Cheddar cheese aged-4 months	Dairy	-	-	-	77.8	16.5	Values differ as per variety of cheese approx. Glutamate 180~1680 (mg/100g) EUC
Oyster sauce	Seasoning	-	-	-	900	240	For fresh oyster glutamate values 40~150 (mg/100g) EUC
Dark soya sauce	Seasoning	-	-	-	1078	184	Fermented food product naturally occurring glutamate ranges 400~1700 (mg/100g) EUC
Yeast extracts (UK)	Seasoning	0	0	-	1110	730	Value as per (mg/100g) EUC
Seaweeds	Algae	-	-	-	1350	-	Values differ as per varieties approx. glutamate 2~3380 (mg/100g) EUC

METERIALS AND METHODS

Preparation of the soup mix:

Vegetables like cabbage, carrot, spring onions, and French beans were sourced from Dadar market in Mumbai, washed, peeled, and chopped into uniform pieces. 500g of each vegetable were dehydrated in a tray dryer at 90°C for 5-6 hours, then weighed. Other ingredients included corn flour, ginger powder, garlic powder, onion powder, salt, and soya sauce powder. Garlic and onion powder were from Snapin, while ginger powder and corn flour were locally sourced. Soya sauce powder was made by mixing soya sauce with cornstarch (1.5:1), forming a dough, and dehydrating it at 100°C for 3 hours.

Umami flavor enhancers like yeast extract (Masala Potli Inc.) and shiitake mushroom powder (e-commerce- Amazon) were used. The vegetables were mixed in a 1:2:1 ratio. Three 100g samples were prepared: Sample A (control), Sample B (1% shiitake mushroom powder), and Sample C (1% yeast extract) for flavor enhancement.

Nutritional Analysis:

Analysis was done to identify the appropriate amount of crude fiber, carbohydrates by Lane and Eynon method, fats by Soxhlet method. Estimation of total proteins was done by Biuret method as well as Kjeldahl method. Estimation of iron was done by Ramsay method and phosphorus by Fiske and Subbarao method at 620 nm. The quality of proteins was determined by Paper Chromatography. Shelf-life studies of the product was done by microbial analysis where the products were tested on day 0, day 15, day 45 and day 60 to check the stability of the product. Microbial analysis was done using two methods, Total plate count using Tryptone Glucose Yeast Agar and Yeast and Mold count using CYEG agar.

Sensory evaluation:

Sensory evaluation was done using a 7-point hedonic rating scale to understand the acceptability of the product in the market to evaluate the sensory aspects like flavor, texture, consistency of the product. A sample size of 50 participants, 23 semi-trained and 27 untrained panelists within the age group of 16- 40 evaluated the acceptance of the product.
The sensory characteristics like appearance, color, texture, taste, mouthfeel, after taste and overall acceptability was evaluated. The panelists were given an online score card for the evaluation of the product coded as A, B and C.

RESULTS AND DISCUSSION

Umami, which is often described as the fifth fundamental taste alongside sweet, sour, bitter, and salty, brings a depth and richness to dishes that is highly found in the processed food products and umami food products. The flavor enhancer used for intensifying the umami profile in food products is MSG. Since MSG is predominantly used in the many processed food products and has shown many harmful effects on health of the individuals, recognizing the growing demand for clean-label products and the desire for authentic flavors, the study was aimed to develop a product using natural umami ingredients to enhance the taste of the food product.

Moisture contents of the Soup samples:

According to FSSAI the maximum limit for moisture in any soup powders should not be more than 5% (FSSAI, 2020) [9]. In the current study the moisture values were found to be 2.7% for sample A, 3.3% for sample B and 3.7% for sample C after placing the dish into a hot air oven for 2 hours and weighing the samples. The value obtained was lower as compared to FSSAI guidelines. Sample C showed to have higher moisture content as compared to sample A and sample B.

Protein content in soup samples:

The nutritive value of the food is determined by the protein quality which is mainly determined by the amino acid contents. The estimation of protein was performed by Biuret method where test tubes were measured at 520 nm and a graph was plotted as seen in figure 1. As compared to sample A which is the control sample, sample B and sample C containing mushroom powder and yeast extract were shown to have a higher amount of protein which can be observed in the Table 2.

Total Fat content:

Vegetables usually are lower in fat content. The fat value of the soup premix was found to be 0.07 gm% for sample A, 0.2 gm% for sample B and 0.2 gm% for sample C, since there were no major ingredients that contributed to the amount of fat in the food product. Sample C showed to have a higher fat content than sample A and sample B.

Table 2: Protein content by Kjeldahl method and Biuret test

Tests performed		**Sample A**	**Sample B**	**Sample C**
Biuret test	By graph	1.6 g	1.7 g	1.7 g
	By formula	0.2 g	0.2 g	0.2 mg
Kjeldahl estimation		2.5 g	4.9 g	3.5 g

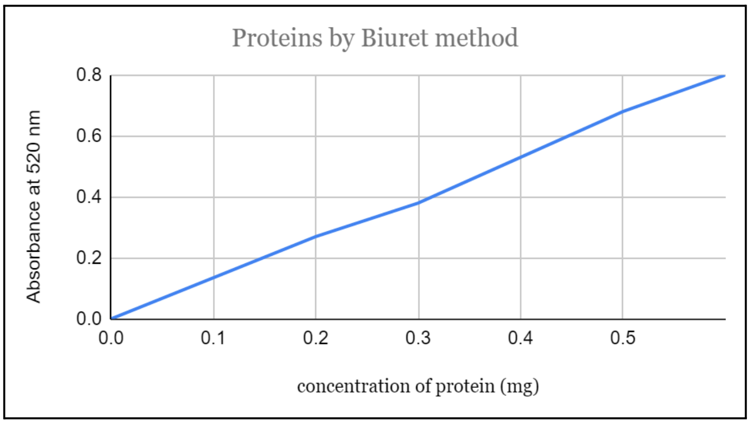

Figure 1: Protein estimation by Biuret method

Carbohydrate content in soup samples:

Carbohydrates estimation was performed by Lane and Eynon method to determine the total sugars present in the dehydrated soup mix. The soup premix contained a lower amount of total sugars since there were no added additional sugars in the soup premix. Sample B showed higher amounts of sugars as compared to sample A and sample C as seen in Table 3.

Table 3: Total sugars by Lane-Eynon method

Parameters	Sample A	Sample B	Sample C
Reducing Sugars	2.12 g	1.1 g	0.87 g
Non reducing Sugars	0.68 g	2.5 g	2.15 g
Total Sugars	2.80 g	3.6 g	3.02 g

Crude Fiber content:

The crude fiber test was done to determine the amount of crude fiber which would help in the estimation of carbohydrates by substitution method. The crude fiber content in sample A was found to be 1% while the crude fiber content of sample B as well as sample C was found to be 0%. The results revealed that the crude fiber content in sample A was found to be in higher amounts as compared to sample B and sample C.

Separation of Amino Acids by Paper Chromatography:

Paper chromatography was performed for the determination of presence of specific proteins which constitute the umami taste of the food product. As observed in Table 4, sample A had closer values to that of aspartic acid. Glutamate and aspartate are the unessential amino acids. These amino acids are found in good amounts in both mushrooms and yeast extracts. While sample A even though did not have any added additional flavor enhancer yet revealed the existence of aspartic acid.

Table 4: Rf values of the amino acids

Amino Acids	Rf value
Methionine	0.04
Glutamic acid	0.2
Aspartic acid	0.21
Sample A	0.24

Sample B	0.23
Sample C	0.23

Phosphorus Content:

An important element called phosphorus may be found in many foods biologically and as a dietary supplement. Shiitake mushrooms contain about 6% of phosphorus in 100 g whereas yeast extracts contain 2.5% of phosphorus. The amount of phosphorus in the soup samples was determined by the Fiske- Subbarao method. As shown in figure 2, a graph of absorbance against the concentration was plotted. Results estimated that phosphorus content was lower in sample A as compared to sample B and sample C since they contained Shiitake mushroom powder and yeast extracts, while sample B and sample C had equal amounts of phosphorus as seen in Table 5.

Table 5: Phosphorus content by Fiske- Subbarao method.

Tests performed		Sample A	Sample B	Sample C
Phosphorus Estimation by Fiske-Subbarao method	By graph	0.08 mg	0.17 mg	0.17 mg
	By formula	0.09 mg	0.2 mg	0.2 mg

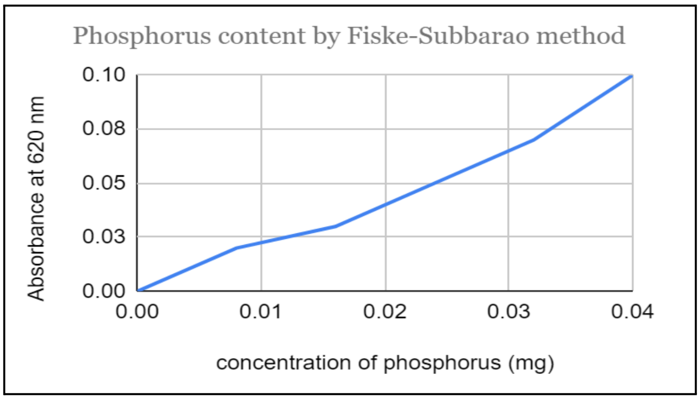

Figure 2: Phosphorus content by Fiske-Subbarao method

Estimation of Iron content:

The iron content of the soup samples was performed using Ramsay's method. The results were calculated using a graph which was plotted for absorbance at 520 nm against concentration of iron as seen in figure 3. Results estimated that iron was found to be in lesser amounts in all the soup samples A, B and C. The soup samples had no presence of foods rich in iron. Yet soup samples B and C had higher concentration of iron as compared to sample A as seen in Table 6.

Table 6: Iron content by Ramsay method

Tests performed		Sample A	Sample B	Sample C
Estimation of Iron by Ramsay method	By graph	0.8 mg	1.4 mg	1.4 mg
	By formula	0.4 mg	0.7 mg	0.7 mg

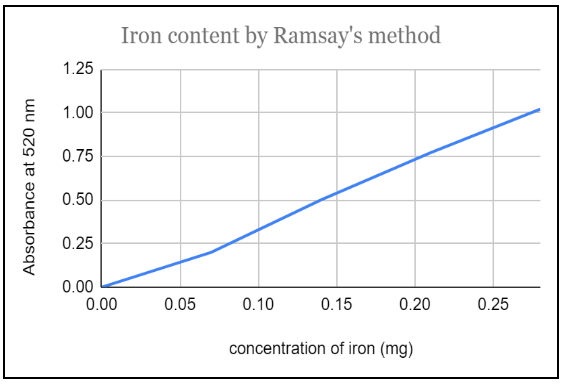

Figure 3: Iron content by Ramsay's method

Microbial analysis of the Food product:

Microbial analysis of the food product was performed by Yeast and Mold Method and Total Plate Count method. The microbial analysis was carried out to determine the bacterial/ fungal growth in the soup premix to determine the stability of the product. Analysis for both the methods was done on day 0, day 15, day 30, day 45 and day 60

The results estimated that no growth was found until day 60 in the food product as seen in the Table 7. Total plate count showed the growth of 8 colonies which is less than 20 colonies. The product was estimated to have a shelf life of 2 months.

Table 7: Microbial growth in soup premix until day 60.

Samples	**Procedure**	**Day 0**	**Day 15**	**Day 30**	**Day 45**	**Day 60**
Sample A	Y and M	-	-	-	-	-
	TPC	-	-	-	-	-
Sample B	Y and M	-	-	-	-	-
	TPC	-	-	-	-	-
Sample C	Y and M	-	-	-	-	-
	TPC	-	-	-	-	6 colonies found

Sensory Analysis:

The sensory evaluation of the soup premix was performed by a 7-point hedonic rating test where 50 individuals participated in the sensory evaluation. The score for sensory attributes of the soup premix with natural flavor enhancers are presented by the radar chart. The results of the sensory testing revealed that sample C which contained yeast extract showed more acceptability than sample B and sample A. Fig 4 shows the scores of all soup samples.

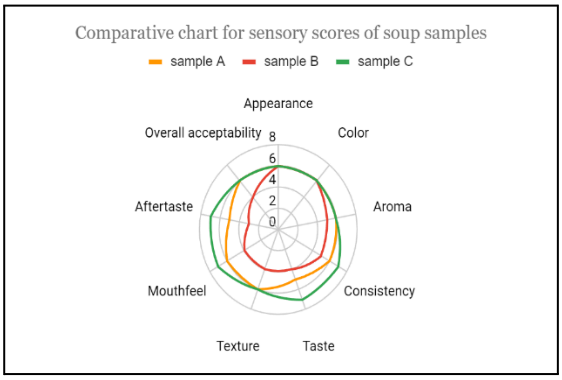

Figure 4: Comparative chart for sensory scores of soup samples

CONCLUSION

Food additives and enhancers are widely used to improve the taste, stability, and quality of products. Monosodium glutamate (MSG) is a common umami flavor enhancer, but long-term use has shown various side effects. This project explored natural umami ingredients as alternatives to MSG in dehydrated soup premix. Three formulations were prepared: Sample A (control), Sample B (with shiitake mushroom powder), and Sample C (with yeast extract powder). Nutritional analysis revealed that Sample B had higher protein content, while Sample C showed variations in total sugars and iron content. Chemical analysis assessed ash content, moisture levels, and microbial stability, confirming all samples met FSSAI safety standards with acceptable shelf life. Sensory evaluation found Sample C most acceptable due to its intense flavor, while Sample B tasted sour due to the shiitake mushroom powder. Future research should optimize formulation ratios, conduct sensory evaluations across age groups, and assess consumer acceptance. Investigating the economic feasibility and scalability of using natural umami ingredients in soup formulations is essential for commercial success. Overall, natural umami ingredients like shiitake mushroom powder and yeast extract offer promising opportunities for enhancing soup flavor and nutrition, appealing to consumers seeking natural alternatives.

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Conflicts of Interest

The authors certify that there are no conflicts of interest with respect to this article.

REFERENCES

1. Diepeveen J, Moerdijk‐Poortvliet TC and van der Leij FR. Molecular insights into human taste perception and umami tastings: A review. Journal of Food Science, 2022; 87(4): 1449–1465.
2. Gao J, Fang D, Muinde Kimatu B, Chen X, Wu, X, Du J, Yang Q, Chen H, Zheng H, An X, Zhao L, Hu Q. Analysis of umami taste substances of morel mushroom (*Morchella sextelata*) hydrolysates derived from different enzymatic systems. Food Chemistry, 2021; 362: 130192.
3. Schmidt CV, Mouritsen OG. Umami taste as a driver for sustainable eating. International Journal of Food Design, 2022; 7(2): 187–203.
4. Lu H, Lou H, Hu J, Liu Z, Chen, Q. Macrofungi: A review of cultivation strategies, bioactivity, and application of mushrooms. Compr. Rev. Food Sci. Food Saf. 2020, 19, 2333–2356.
5. Zhao J, Wang T, Zhang C, Han, X, Yan, J, Gan, B. A comparative analysis of the umami taste of five fresh edible mushrooms by simulating the chemical environment of oral digestion in vitro. LWT, 2023; 176, 114522. 7Umami Database | Umami Information Center. (n.d.). Umami Information Center.
6. Alim A, Yang C, Song H, Liu Y, Zou T, Zhang Y, Zhang S. The behavior of umami components in thermally treated yeast extract. *Food Research International*, 2019; *120*, 534–543.
7. Wang H, Wang W, Zhang S, Hu Z, Yao, R, Hadiatullah H, Li P, Zhao G. Identification of novel umami peptides from yeast extract and the mechanism against T1R1/T1R3. Food Chemistry, 2023; 429, 136807.
8. Wang S, Adhikari K. Consumer perceptions and other influencing factors about monosodium glutamate in the United States. Journal of Sensory Studies, 2018; 33(4).
9. FSSAI Standards Regulations 2020, Food Product Standards and Food Additives.
10. Mahajan D, Kumari H, Punj Pankaj P. Physiological effects of monosodium glutamate – a food additive on human health: a review. Journal of Experimental Zoology India, 2023; 26(2).
11. Wijayasekara K, Wansapala J. Comparison of a flavor enhancer made with locally available ingredients against commercially available Mono Sodium Glutamate. International Journal of Gastronomy and Food Science, 2021; 23: 100286.
12. Hajihasani MM, Soheili V, Zirak MR, Sahebkar A, Shakeri A, Natural products as safeguards against monosodium glutamate induced toxicity. Iran. J. Basic Med. Sci. 2020; 23(4): 416- 430.
13. Morelli CF, Cutignano A, Speranza G, Abbamondi GR, Rabuffetti M, Iodice C, De Prisco R, Tommonaro G. Taste Compounds and Polyphenolic Profile of Tomato Varieties Cultivated with Beneficial Microorganisms: A Chemical Investigation on Nutritional Properties and Sensory Qualities. Biomolecules, 2023; 13(1), 117.
14. Niaz K, Zaplatic E, Spoor, J. (2018). Extensive use of monosodium glutamate: A threat to public health? EXCLI journal, 17, 273–278.
15. Poojary MM, Orlien V, Passamonti P, Olsen K. Improved extraction methods for simultaneous recovery of umami compounds from six different mushrooms. Journal of Food Composition and Analysis, 2017; 63: 171–183.
16. Wang S, Zhang S, Adhikari K. Influence of monosodium glutamate and its substitutes on sensory characteristics and consumer perceptions of chicken soup. Foods, 2019; 8(2).