Journal of Food Technology Research
2023 Vol. 10, No. 3, pp. 75-92
ISSN(e): 2312-3796
ISSN(p): 2312-6426
DOI: 10.18488/jftr.v10i3.3493

Unravelling the potential of rice congee: A review of its physicochemical properties, processing methods, functional food opportunities, and current hurdles

Noor Farisya Mohd Shaharom[1]
Lay-Jing Seow[2]
Anida Yusoff[3]
Eng-Keng Seow[4+]

[1,3,4]*Department of Food Science and Technology, School of Industrial Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.*
[3,4]*Food Science Research Group, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.*
[1]*Email: farisyanoor98@gmail.com*
[3]*Email: anida@uitm.edu.my*
[4]*Email: ekseow@uitm.edu.my*
[2]*Faculty of Pharmacy and Health Sciences, Universiti Kuala Lumpur Royal College of Medicine Perak, 30450 Ipoh, Malaysia.*
[2]*Email: ljseow@unikl.edu.my*


(+ Corresponding author)

Article History
Received: 25 May 2023
Revised: 12 September 2023
Accepted: 27 September 2023
Published: 6 October 2023

Keywords
Congee
Elderly
Functional food
Functional ingredients
Instant fortified congee
Porridge.

ABSTRACT

The purpose of the article is to go through how to make porridge and congee, how processing factors affect the physicochemical and nutritional qualities of porridge and congee, and how to fortify and replace functional components in instant porridge and congee. Nowadays, consumers are expressing an increase in desire for food products that are more nutritious, accessible, and natural without compromising on health objectives, flavors, or ingredients. Most significantly, these food products must aid consumers in keeping up with their hectic schedules. Porridge, or congee, is well-known for being a nutritious dish that is simple to prepare, easy to digest, and great for feeding the sick and toothless, such as infants and the elderly. In spite of that, porridge, or congee, is a starchy food with a low nutritional content. The use of different kinds of beans, grains, and vegetables as functional ingredients could provide higher nutritional values as compared to plain porridge or congee. Thus, food researchers take the initiative in developing instant fortified porridge and congee to fulfil consumers' demand for a healthy and convenient food. Previous studies have proven that instant fortified porridge and congee have significantly improved the nutritional content of plain porridge and congee. Overall, this review provides valuable insights into the potential contribution of rice congee to the dietary needs of consumers (especially the elderly), shedding light on its significance as a functional food option.

Contribution/Originality: This review unveils the role of rice congee as a functional food. By synthesizing current research findings, it highlights the specific advantages of instant fortified rice congee in addressing the nutritional needs and age-related health concerns of the elderly, offering insights into future research directions and potential innovations in the field.

1. INTRODUCTION

1.1. Porridges

Cereal porridges are basically made from common grains, such as rice, maize, wheat, oats, or sorghum. Although porridge can be cooked with any type of grain, rice is typically used in the majority of Asian countries because it is the region's staple diet. They are frequently prepared with a large amount of water, and the grains that

swell during cooking give them a viscous texture. The viscous texture of porridge makes it easy for one to chew, swallow, and digest, as it is categorized as a semi-fluid food (Gaikward, Sawate, Kshirsagar, Veer, & Mane, 2019). A similar method is also mentioned by Wang et al. (2019), wherein porridge is often made by mixing water with the grains (approximately 7:1 (v/w) water to grain), followed by heating for a few hours until it becomes a semi-liquid food. The cooked porridge, however, can only be kept at room temperature for a short period of time (Wang et al., 2019). Porridge is a cereal-based liquid-to-semi-solid food product with a soft texture that can be consumed by people of all ages, particularly infants, the elderly, and those who are convalescing, due to its smoothness and ease of ingestion (Katunzi-Kilewela et al., 2022).

1.2. Rice Congee

Garcia and Da (2011) reported in literature that congee is the name of a traditional Chinese rice porridge breakfast. There is evidence found that congee originated in China from the Yuan dynasty (1271–1368) to at least the Qing (1644–1912), in terms of monastic production and consumption of *"hong zao"* as a type of congee. *"Hong Zao" is* basically an alcoholic fermented grain mash prepared from rice (Toleno, 2017). Thus, it can be said that congee is a type of porridge that is made from rice grain. Rice and water are the two most prevalent ingredients in different forms of congee. Based on Toleno (2017), the definition of congee is a semi-liquid mush obtained by boiling the rice grain in water or broth. Congee is a starchy staple diet that has become a common food in many cultures. Apart from that, congee can be altered by adding savoury or sweet ingredients based on the preferences of the consumers.

Because congee was simple to prepare and digest in ancient times, poor people or those who were ill ate it (Toleno, 2017). It is similar to a Korean rice porridge called *"Jook"*, which is a traditional Korean comfort food normally prepared for patients or old people, and it is also used as a main dish, appetizer, or diet food (Rhim, Koh, & Kim, 2011). Rice congee is also eaten as breakfast food for adults. Moreover, consuming rice congee as breakfast on a daily basis probably originates from China, and nowadays it has become a tradition for Southeast Asian countries such as Thailand, Cambodia, Philippines, and Indonesia. The rice congee has different names based on their own language. For example, in Thailand, rice congee is called *"Jok"*, *"Babor"* in Cambodia, *"Lugaw"* in Philippines, and lastly, *"Bubur"* in Indonesia and Malaysia.

A variety of congee attributes, such as water-to-rice ratio, rice softness, and congee consistency, differ by region (Karen et al., 2021). Not only that, rice congee can be categorised based on its consistency, texture, and viscosity, according to the International Dysphagia Diet Standardisation Initiative (IDDSI). In Hong Kong, there are two prevalent variations of rice congee, namely Cantonese-style and Chiu Chow-style congees. Cantonese-style congee is classified as Level 5, characterised by a minced and moist texture. On the other hand, Chiu Chow-style congee has a mixed consistency, with the rice component falling within IDDSI Level 7 (regular) and the watery component lying within IDDSI Level 0 (thin). While for Singapore congee, it can be classified under IDDSI Level 3 (liquidised) or IDDSI Level 4 (pureed). On the other hand, Malaysian congee mostly ranges from IDDSI Level 3 (liquidised) to IDDSI Level 5 (minced and moist). This type of congee can be prepared by mixing rice and water at a ratio of 1:10 and cooking in a pot on low heat for at least 30 minutes (Karen et al., 2021).

Moreover, rice congee is well recognised and readily available in Southeast Asian nations, including Malaysia, Indonesia, and Singapore, due to its classification as a wholesome and palatable dish that may serve as a satisfying and nutritionally balanced meal. As a result, rice congee has gained popularity, prompting fast-food establishments to capitalise on this trend by incorporating rice congee into their product offerings (Jian et al., 2021). In Malaysia, fast-food restaurants such as MacDonald, Texas Chicken, and Marrybrown serve chicken rice congee that is accessible throughout the day and suits the taste of Malaysians. In Indonesia and Singapore, their McDonald's restaurants serve rice congee as breakfast, which shows the demand for rice congee in both countries.

In addition, congee can be improved by adding savoury or sweet components, depending on what the customer like. Those days are gradually choosing to include more healthful foods in their diets. Thus, a variety of rice congee recipes incorporating nutritious items such as beef, fish, mushrooms, and abalone have been created as healthful cuisine (Rhim et al., 2011). Moreover, rice congee is chosen as a late-night snack because it is a perfect dish for easy digestion and less likely to cause any uneasy feelings in the stomach. It is easy to prepare and requires minimal cooking skills, so everyone can prepare healthy food by themselves. They may also add any healthy ingredients to their rice congee that suit their taste preferences.

In modern life, people demand easy, fast, and convenient things, including their daily food. Convenience food products are fast and easy to prepare; thus, shorter cooking times and only minimal cooking skills are required (Gaikward et al., 2019). In order to keep up with the fast pace of modern living, the demand from consumers for convenient and accessible processed rice-based products has led to the market's continuous growth (Li et al., 2021). Because there is a great demand for these convenience food items these days, the food business decided to create an instant rice congee to satisfy consumer demand. One type of convenience food is instant rice congee, which is manufactured from rice using a number of steps, including cooking, drying, and packaging. Presently, there are a variety of instant rice congees available on the market (Mayachiew, Charunuch, & Devahastin, 2015). On the other hand, instant rice congee is developed to increase the shelf life of rice products with the aid of packaging for serving (Purbowati, Wening, Afiatna, Maryanto, & Nasifah, 2021).

1.3. Consumers of Instant Rice Congee

Dried food is regarded as an instant food that satisfies the needs of consumers due to the changing circumstances of modern life. The rise in the number of people who live alone and lack of time to prepare meals resulted in an increase in demand for these instant foods (Mahgoub, Mohammed, & Mobarak, 2020). Instant fortified rice congee has been designed and developed to meet consumer demand for a healthy and easy-to-prepare food that requires minimal cooking skills. Besides, instant fortified rice congee is a dried food that has flavour stability at room temperature for long periods of time, which is up to 6-12 months. Due to its lower moisture content, this product is protected against enzymatic and oxidative activity damage. Thus, people who live alone and have been busy with their daily lives and do not have much time to prepare a proper meal could be the target consumers for this product.

Furthermore, research by Akbar, Politeknik, Makassar, Politeknik, and Mahsyar (2022) focused on developing an instant fortified rice congee for the elderly. This is because rice congee is seen as the perfect food for the elderly to consume due to its smooth texture and quick preparation. It is common for older people to have declining physical health. Elderly people with this syndrome will have impaired organ function. Disorders of the digestive system are a common problem that affect both physical and mental health. In addition, considering the fact that older people's teeth are no longer perfectly arranged, it is important to know that food consumed by the elderly must have a soft texture. Hence, it is necessary to develop an instant rice congee that is suitable for the elderly to consume.

Beginning at six months old and onwards, complementary feeding must be timely and sufficient in terms of amounts, frequency, consistency, and using different kinds of foods. In line with the baby's developmental stage, complementary foods should have the right texture and consistency. Baby rice porridge is one of the main examples of complementary feeding due to its complete nutrients, and the number of servings and the level of density could be customized according to the age of the infant or child (Purbowati et al., 2021). Therefore, the development of instant fortified rice congee as a healthy and complementary food could be focused on infants or children too. Despite its nutritional composition, an instant rice congee also only requires a short cooking time and is easy to prepare. Mothers with infants or children have limited time to prepare a healthy and complete meal because they

are busy managing their household. The convenience of this food could help solve the problems faced by a busy mother.

Porridge is a popular, nutritious breakfast meal made from a variety of cereals or legumes that have been boiled in milk or water to a mushy consistency (Mišan et al., 2017). Thus, the soft texture of porridge is claimed to be suitable for ingestion and digestion without any difficulties. Usually, doctors advise patients to eat porridge. Besides, dysphagia patients (people with swallowing difficulties) frequently experience dehydration, weight loss, aspiration pneumonia, and airway obstruction. Swallowing problems are a group of diseases and conditions that cause difficulty moving food or fluids from the mouth to the esophagus. Under these circumstances, patients with dysphagia must consume foods that are soft enough to chew and swallow with ease. A recent study by Yong, Abidin, Rozalli, and Wahab (2023) developed an instant rice porridge with the addition of xanthan gum as an alternative thickener to reduce the risk of choking among dysphagia patients. Furthermore, instant rice porridge for celiac disease patients who are gluten-sensitive has also been developed. Legumes are blended with rice in order to supply essential amino acids (Mayachiew et al., 2015). Instant porridge is one of the porridge variations that is easy to prepare because it does not require cooking but simply the addition of warm water, making it ideal for patients.

1.4. Instant Rice Congee Fortified or Substituted with Functional Ingredients

Today's market offers a variety of rice-based products; one of them is instant rice congee. It can be categorized as a value-added product made from broken rice, which is then one of the most well-liked foods because of its convenience. However, instant rice congee is usually classified as a starchy food that has a low protein content. The nutritional composition of rice congee alone may not be able to meet the dietary requirements (Akbar et al., 2022). According to Malaysian Food Composition Database (1997), instant fish rice porridge has 76.4% carbohydrates, 9.9% protein, 6.6% moisture, 6.5% ash content, 0.3% fat, and 0.3% fiber content.

Thus, the development of a healthy instant rice congee that is fortified with other functional ingredients could be an alternative to fulfilling the current market demand (Mayachiew et al., 2015). Rice congee that is fortified with functional ingredients can be classified as a functional food. Functional food is food that is enriched or enhanced with bioactive ingredients. By considering today's consumer demand for healthy and convenient foods, the use of different kinds of beans, grains, and vegetables, which provide higher nutritional values as compared to plain rice congee, is a great alternative. Recent research suggests, that beans, grains, and vegetable congees surpass plain rice congee not only in textural and sensory attributes but also in biological activity such as antioxidant effects. Recently, most of the ingredients used in developing congee with added health value produced desirable physical properties and acceptable sensory quality that had the possibility of meeting the requirement for daily dietary intake (Shim & Lim, 2013).

In earlier studies, it was possible to boost the nutritional value of instant congee and porridge by using functional ingredients that are accessible on the market, such as pumpkin, which is high in vitamin A, or oyster mushroom, which is high in potassium (Table 1). Besides, the functional ingredients used are also capable of providing benefits for specific diseases, such as dysphagia, patient with celiac disease, and mild to moderate hypercholesterolemia. Patients with dysphagia need food that is easy for them to swallow. Thus, congee is thickened with the addition of xanthan gum as a functional ingredient, ensuring a consistent thickness and texture to facilitate swallowing (Yong et al., 2023). Soy bean is claimed to have a high protein content and also contains many health-promoting bioactive compounds that provide sufficient essential amino acids for patients with celiac disease (Mayachiew et al., 2015). Apart from that, maize is substituted with buckwheat by 39% because of its potential beneficial effects, which are antidiabetic, anti-hypercholesterolemic, anti-oxidative, anticancer, and anti-inflammatory effects (Mišan et al., 2017).

Table 1. Functional ingredients and their benefits.

Functional ingredients	Benefits	References
Soybean	• High in protein • High in bioactive compounds	Mayachiew et al. (2015)
Buckwheat	• High in antioxidants • Have antidiabetic, anti-hypercholesterolemic and anti-inflammatory effects	Mišan et al. (2017)
Pumpkin	• High in vitamin A	Slamet, Kanetro, and Setiyoko (2021)
Oyster mushroom	• High in potassium	Akbar et al. (2022)
Xanthan gum	• Thickening agent	Yong et al. (2023)

2. RICE

Rice (*Oryza sativa* L.), a member of the Poaceae family and subfamily Oryzoidea, is one of the largest food crops in most of the countries in Asia, Africa, and South America (Lina & Min, 2022). It is one of the main staple foods consumed by 70% of the global population, making up one-fifth of all land used for cereal crops (Panesar & Kaur, 2015). China ranks first in the world with its more than 200 million tons of rice yield and a planting area of about 30 million hectares (Li et al., 2021). Apart from that, there are approximately 100,000 rice varieties, but only a small number of the rice varieties are literally cultivated in the world. Rice is varied in its grain weight, size and shape, degree of grain dormancy, longevity, and seedling vigour, while some of them have red to purple-black pigments (Juliano, 2015). Besides, rice is also regarded as one of the most significant and nutrient-dense cereal crops in the world due to its use either as human daily food or as animal feed (Verma & Srivastav, 2020). Half of the world's population consumes rice in the form of white rice as a staple diet (Abhilasha et al., 2021). According to Li et al. (2021), rice is a naturally gluten-free and hypoallergenic food component. This is proven by a database of officially designated allergens maintained by the Allergen Nomenclature Subcommittee of the World Health Organization (WHO) and the International Union of Immunological Societies (IUIS). The database stated that there are more than 230 food allergens from 74 plant species, but there are no known food allergens that come from rice or its variety.

Naturally, the raw form of rice is a paddy, which is then processed into a variety of forms, such as brown, milled, parboiled, and colored, based on consumer preferences and health considerations. To increase the production and nutritional value of rice, numerous research initiatives, including genetic engineering, have been studied (Panesar & Kaur, 2015).

An unmilled whole grain rice with a mild, nutty flavour is known as brown rice (Panesar & Kaur, 2015). Brown rice (Figure 1 (a)) consists of the endosperm, germ, or embryo, which is made up of maternal tissues, the outer layers of pericarp, seed coat, and nucellus (Juliano & Hicks, 1996). Amylose content in brown rice is low, at about 3.36% (Thomas, Wan-Nadiah, & Bhat, 2013). The main nutritional benefit of brown rice as compared to milled rice is its higher content of vitamin Bs. Despite their higher mineral content, bran phytic acid forms complexes with minerals and proteins, which lowers their bioavailability. Therefore, the available iron is similar in both brown and milled rice, but the zinc content is probably higher in brown rice as compared to milled rice. In addition, brown rice and bran have a higher fat content, hence a higher energy content than milled rice (Juliano, 2015). It is also evidenced that brown rice is abundant in dietary fiber, functional lipids, amino acids, vitamins, phytosterols, phenolic compounds, gamma-aminobutyric acid (GABA), and minerals (Abhilasha et al., 2021). However, brown rice has some weaknesses, such as a slower rate of water absorption into the kernel and a longer cooking time due to the existence of an outer fibrous bran layer.

Milled or white rice, as presented in Figure 1 (b), is a rice grain that has been processed by removing the husk and bran layers (Panesar & Kaur, 2015). Some crucial nutrients are lost during the milling and polishing steps in

order to create white-milled rice. In comparison to brown rice, white rice that has gone through the milling process has less zinc, protein, minerals, and lysine content. Abhilasha et al. (2021) also mentioned this fact: because of the loss of the bran layer during polishing, white rice is deficient in a vast array of beneficial nutrients and bioactive compounds. Nevertheless, consumption of milled rice is normally more acceptable than brown rice because of easy digestion, short cooking time, and the low amount of water used for cooking. More importantly, the colour and texture of cooked milled rice that is white and fluffy are appealing to consumers (Panesar & Kaur, 2015). According to Thomas et al. (2013), the dry and fluffy texture of cooked white rice is due to the presence of a high amylose content of about 27%.

According to (Jayaraman, Uluvar, Khanum, & Singh, 2019), making parboiled rice traditionally involved soaking the paddy for about three days at room temperature, followed by a steaming procedure and drying. It has been claimed that parboiled rice is nutrient-dense. This is due to most of the nutrients from the hard outer hull moving to the inner section of the kernel during processing, which involves soaking and steaming the rice kernels under high pressure, which makes the hull then fall off. The finished product, which is parboiled rice, is rich in vitamins and minerals and has a very low glycemic index (Panesar & Kaur, 2015). According to Juliano and Hicks (1996), in the United States, most common parboiled rice is a long-grain intermediate amylose content rice, while in Italy, parboiled rice exists as the intermediate to low amylose content japonica rice. An example of parboiled rice is demonstrated in Figure 1 (c).

There are two types of pigmented or colored rice varieties: unpolished and semi-polished. Zinc and iron are abundant in red-pigmented rice varieties, whereas crude fiber, protein, and fat predominate in black-pigmented rice varieties. Anthocyanin pigments, which are responsible for giving rice purple, black, red, and brown colours, are present in trace amounts in these rice grains (Kowsalya, Sharanyakanth, & Mahendran, 2022). This pigment is rich in phytochemicals and antioxidants (Priya, Eliazer Nelson, Ravichandran, & Antony, 2019). As stated earlier by Panesar and Kaur (2015), the colour of the grain has an impact on its nutritional value as well. Researchers have discovered that the colour of rice is basically due to the presence of bioactive compounds. For example, in purple rice, hydrophilic antioxidants predominate over lipophilic antioxidants. Additionally, studies revealed that the inner portion of the purple rice bran contains most of the beneficial compounds. Likewise, black rice and red rice contain pigments that prevent atherosclerosis from developing and lower cholesterol levels, whereas these pigments are unavailable in milled white rice (Panesar & Kaur, 2015). Figure 1 (d) shows an example of black rice.

According to Panesar and Kaur (2015), glutinous rice, also known as sticky rice or waxy rice, is primarily grown in Southeast and East Asia. The grains (Figure 1 (e)) have a very low amylose content, are opaque, and become sticky when they are cooked. In contrast to rice that contains amylose, all glutinous rice has sticky and adherent kernels that give the finished product a noticeably distinct texture (Noomhorm, Kongseree, & Apintanapong, 1997). The sticky nature of glutinous rice is owing to the presence of amylopectin. According to Qiu, Abbaspourrad, and Padilla-Zakour (2021), glutinous rice grain has 83.1% of total starch, which is mainly amylopectin (98.2%). It also contains a large amount of protein, about 8.4%. Moreover, the absence of amylose in the starch of glutinous rice is the most distinctive feature as compared to the other types of rice. Glutinous or waxy rice is frequently used to make baked or popped snacks because it expands easily and creates a more porous texture (Noomhorm et al., 1997).

Figure 1. Type of rice.

White rice has the advantage of being able to be kept for a long time without any special packaging or storage procedures, which led to lower initial investment costs that benefited the industry. In comparison with white rice, brown rice requires modified atmospheric conditions for packaging, such as flushing in carbon dioxide and vacuuming, in order to delay the quality deterioration of brown rice. Given that the bran layer of brown rice contains high lipids, it is more likely to become rancid due to oxidation, which shortens its shelf life when it is stored for an extended period of time. Unlike white rice, which can be stored for up to two years, brown rice can be stored at ambient temperature for only three to six months. Moreover, brown rice is more susceptible to insect infestation, which is one of the factors contributing to its shorter shelf life (Mir, Shah, Bosco, Sunooj, & Farooq, 2020). Besides, the absence of a bran layer in white rice makes it easier to hydrate water and leads to a shorter cooking time.

White rice is sometimes unfavorable, although it might be a preferred choice to brown rice in some circumstances. For example, people on a low-fiber diet, as well as people suffering from nausea or heartburn, may discover that white rice is easily digestible and does not cause any gastrointestinal side effects. A low-fiber diet is advised for those who have diverticulitis, diarrhea, or who have undergone surgery on their stomach or intestines, all of whom have disorders affecting the digestive system. When a low-fiber diet is required, white rice is a preferable option because it has less fiber than brown rice, which causes the body to digest it easily (Khalua, Tewari, Mondal, Ranajit, & Khalua, 2019). In comparison with other grains such as wheat, barley, and rye, white rice is gluten-free. Gluten itself is a complex protein that is difficult for the body to digest. Besides, research by Gondal et al. (2021) shows that consumers prefer white rice over other rice varieties in terms of texture (hardness and

chewiness) and colour. Differences in odour best explain the variety in liking of white rice, but texture is the most significant sensory attribute that justifies the difference in liking between brown and white rice.

Sterman (2015) suggests that high-quality medium- or long-grain Asian-style white rice should be used in making a good congee. The use of short-grain or risotto rices should be avoided as they are too sticky. White rice has a soft texture, and extreme grain elongation with breadth-wise expansion occurs during cooking. Over the course of cooking, the grain absorbs the fluid. Therefore, it is perfect to make rice congee using white rice, as it will give the rice congee a smooth, starchy, and silky texture. In comparison to brown rice, the grain of brown rice will most likely remain intact during the cooking process (Giraud, 2013).

3. THE MAKING OF PORRIDGE AND CONGEE

There are several methods (Table 2) used in cooking porridge, which vary according to region and culture. However, simmering is widely regarded as the predominant method for the preparation of congee or porridge and is sometimes classified as a traditional culinary technique. In the typical preparation of porridge, it is customary to rinse rice or other grains in order to eliminate any potential pollutants before commencing the cooking process. In the customary practice observed in Korea, it is common to immerse rice in chilled water for a duration of 1-2 hours prior to its transformation into porridge. Then, the wet rice is added to a stainless-steel pot and cooked at a medium-high temperature while being stirred occasionally with a wooden spoon (Shim & Lim, 2013). In comparison, Tang, Cai, and Xu (2016) mentioned that the soaking period for ordinary home-cooking of rice porridge in China is 2.5 hours. Normally, pre-cooking methods involve rinsing to remove contaminants and soaking prior to cooking to shorten the cooking period. It is claimed that these pre-cooking methods are different between countries (Yamuangmorn, Dell, & Prom-U-Thai, 2018). Based on the statement by Chen et al. (2021), Chinese folks normally prepare porridge by adding water or broth around 20 times the weight of the rice and simmering it at room temperature. A similar cooking method is used in Malaysia, where the rice is mixed with 10 times as much water and the porridge is usually cooked in a pot on low heat for at least 30 minutes (Karen et al., 2021). Meanwhile, in Japan, *"okayu"* is a Japanese rice congee that is prepared by using a ratio of rice to water of about 1:5, which is considered much thicker than the rice porridge made in other countries (Keawkaika, Suzuki, & Hagura, 2010).

Nowadays, the majority of Asian households own an electronic rice cooker to make life easier by reducing the amount of time spent stirring rice congee in a pot on the stove. Nguyen et al. (2014) prepared rice congee using an electronic rice cooker. Rice is washed with tap water once before soaking in water, with a ratio of rice to water of 1:1.5 for 1 hour. The soaked rice was cooked in an electronic rice cooker using an embedded program for porridge at 100°C for 1 hour and 20 minutes with a ratio of rice to water of 1:6. A similar process for cooking millet porridge was done by Zhang et al. (2022). The first step is washing the millet grains twice with purified water. Then, the washed millet was placed in an electronic cooker filled with purified water using a millet-to-water ratio of 1:14. The mixture was left boiling in an electronic cooker for 40 minutes in order to obtain the millet porridge. Besides, Tang et al. (2016) also used an electronic rice cooker to prepare black rice porridge. The black rice was soaked in water with a ratio of rice to water of 1:5 for 2 hours and 30 minutes before it was cooked. Without draining the soaking water, the soaked rice was cooked in an electronic rice cooker for 20 minutes with a rice-to-water ratio of 1:6.

Instead of simmering in a pot over low heat, you can also steam porridge. The reason why some people frequently steam their porridge is to ensure that it does not dry out and adhere to the bottom of the pot. As a result, simply rinsing the pot with water is adequate to clean it. The steaming process, also known as double boiling, ensures that the temperature stays constant at around 100 °C, but most of the nutrients in the food are still retained. Normally, cooking porridge with the steaming method uses a ratio of grains to water of 1:3, and the process can be done in 15 to 20 minutes at 100°C. Several food manufacturers employ the steaming technique to produce instant porridge, which is often known as ready-made porridge. The first step is milling and resizing the

grains before dry-mixing them. Then, water is added to facilitate the required steps of steam cooking and gelatinization. Following the steaming process, the water and grain slurry are dried using a drum dryer, yielding powder with a moisture content of 6% (Sieti, Rivera, Stamford, & Azapagic, 2019).

Table 2. Method and process of making porridge and congee.

Method of making porridge and congee	Process of making porridge and congee	References
Simmering	Wash and rinse the grains → Soak grains for 2-3 hours → Cook porridge with medium heat for 30 minutes with a ratio of rice to water, at 1:10 or 1:20	(Chen et al., 2021; Karen et al., 2021; Shim & Lim, 2013; Tang et al., 2016)
Cook using electronic rice cooker	Wash and rinse the grains → Soak grains for 1-2 hours → Place the soaked grains in electronic rice cooker with a ratio of rice to water, at 1:6 or 1:14, and cook for 40 minutes to 1 hour	(Nguyen et al., 2014; Tang et al., 2016; Zhang et al., 2022)
Steaming	Mill and resize the grains → Steam porridge for 15-20 minutes at 100°C with a ratio rice to water, at 1:3	Sieti et al. (2019)

4. EFFECT OF PROCESSING PARAMETERS ON PHYSICOCHEMICAL AND NUTRITIONAL PROPERTIES OF PORRIDGE AND CONGEE

The effect of processing parameters on physicochemical and nutritional properties of porridge and congee is tabulated in Table 3. It was found that the temperature and pressure of cooker have an impact on the quality of porridge in terms of aroma, nutrition, and texture. Rice congee quality is also determined by the type of rice, water-to-rice ratio, and the pre-set cooking technique of the electric cooker (Roy, Shimizu, & Kimura, 2007; Zhang et al., 2022). Besides, a study by Bett-Garber, Champagne, Ingram, and McClung (2007) showed that a high amount of water used in cooking rice can increase the intensity of textural qualities, initial starchy coating, stickiness between rice grains, smoothness, cohesiveness, and biting uniformity. In contrast, the intensity of hardness, springiness, and chewiness decreases with the amount of water used in cooking rice.

The size of the rice grain has an impact on viscosity and shear modulus. As the size of rice grains decreases, viscosity and shear modulus also decrease. The whole rice grain with a rod shape has a very high value for viscosity and shear modulus, which is about twice the value for viscosity and shear modulus of ground rice. It is claimed that

the application of heat causes the ground rice to soften, resulting in a decrease in viscosity and shear modulus (Keawkaika et al., 2010).

Prior research by Chen et al. (2021) emphasizes that cooking porridge at a higher initial temperature (i.e., 100°C) is more advantageous as compared to cooking at 25°C and simmering with low heat. It was proven that when porridge was cooked with 100°C water for 15 minutes of heating, the varieties of rice flavor increased by 2.2 times, the whiteness of the rice was reduced by 10.04%, the hardness declined by 3.54 times, and the elasticity decreased by 35.48% as compared to the traditional cooking method, which is cooking at 25°C. Besides, high-temperature treatment of the rice congee will affect its viscosity. As has been previously reported in a study by Deng, Wang, Wang, Zhou, and Xiao (2012), different drying temperatures also affect the quality of instant rice porridges in terms of viscosity. Increased drying temperatures cause the retrogradation of rice starch, which raises viscosity values. As reported in the finding, the hot-air drying method with a pasting temperature of 78.4 °C produced the highest viscosity values, followed by freeze-hot air drying (76.7 °C) and freeze drying (76.1 °C). By using the freeze drying method, the gelatinization temperature of the instant rice porridge samples is lower, which decreases their potential to retrograde. However, a different result is reported in a study by Chysirichote and Phongpipatpong (2015), whereas brown rice porridge that has been sterilized at 122 °C for 4.02 minutes has the lowest viscosity as compared to sterilized treatments at 116 °C and 110 °C with the same processing time. This study also mentioned that the process at increased temperature and reduced time results in decreased viscosity.

In addition, it was reported in a study that there were differences in the nutritional value of millet grain, millet soup, and millet porridge cooked in various electric cookers, which were related to the various heating modes and power of the electric cookers. The study showed that foods cooked in electric cooker No. 3, which uses electromagnetic power and a rated power of 820 W, had the most amylose and reducing sugars (Zhang et al., 2022). Furthermore, using a pressure rice cooker instead of an electric rice cooker to prepare black rice increased the loss of anthocyanin, despite the fact that a pressure rice cooker can shorten the cooking time. This is due to the possibility that high pressure leads to the destruction of the bran structure and increases the leaching of anthocyanin (Yamuangmorn et al., 2018). Besides, black rice is soaked and rinsed prior to cooking in order to shorten the cooking period in most Asian countries. However, these pre-cooking methods have caused the loss of anthocyanin as the soaking water becomes dark purple in colour (Tang et al., 2016).

Table 3. Effect of processing parameters on physicochemical and nutritional properties of porridge and congee.

Processing parameter	Effect on phisycochemical and nutritional properties of porridge and congee	References
Ratio of rice to water (High amount of water used)	• Increase the intensity of textural qualities, cohesiveness, smoothness, and stickiness • Decrease the intensity of hardness, springiness, and chewiness.	Bett-Garber et al. (2007)
Size of rice grain (Small rice grain)	• Decrease the viscosity and shear modulus	Keawkaika et al. (2010)
Drying temperature (High drying temperature)	• Increase the viscosity	Deng et al. (2012)
Treatment temperature and time (High treatment temperature, short treatment time)	• Decrease the viscosity	Chysirichote and Phongpipatpong (2015)
Rinse and soak grains before cooking	• Increase the loss of antioxidants	Tang et al. (2016)
Pressure of electronic rice cooker	• Increase the loss of antioxidants (Anthocyanin)	Yamuangmorn et al. (2018)

5. INSTANT PORRIDGE AND CONGEE FORTIFICATION OF FUNCTIONAL INGREDIENTS

Table 4 shows the fortification of functional ingredients in instant porridge and congee in previous studies. Mayachiew et al. (2015) developed an instant rice congee that is fortified with soybeans or mung beans. Among the various legume options, soybean and mung bean are chosen as functional ingredients because they have high concentrations of phenolic compounds, lipids, vitamins, minerals, and protein. This study focused on developing a healthy instant rice congee for patients who suffer from celiac disease. Celiac disease is an immune reaction, whereas the small intestine is sensitive to gluten, which leads to difficulty digesting the food. This disease can happen to anyone at any age, and women would experience it more frequently (Domsa et al., 2022). Instant rice congee that is fortified with legumes is capable of supplying the essential amino acids to patients with celiac disease. Broken white polished rice is chosen as the base product since none of the varieties of rice contain dietary gluten, thus it will be suitable for gluten-free diets (Panesar & Kaur, 2015). So, it has been shown that rice congee that has been fortified with soybean has more total phenolic content, DPPH radical scavenging capacity, ferric reducing antioxidant power (FRAP), amino acid and fat contents, and DPPH radical scavenging capacity than rice congee that has been fortified with mung bean. Thus, instant rice congee fortified with 30% soybean is capable of supplying important essential amino acid, especially lysine, which is limited in rice, to patients who suffer from celiac disease.

Akbar et al. (2022) conducted research on the organoleptic quality of instant oyster mushroom congee in terms of colour, aroma, texture, taste, and overall assessment, which was developed specifically for elderly. This instant congee was developed to solve some problems faced by the elderly. The elderly must take a complete diet despite their conditions, such as imperfections in tooth arrangement and other dental problems. Moreover, high blood pressure is highly common in mature adults aged 45 years and above, while hypertension is more prevalent among the elderly than that of middle-aged people (Benetos, Petrovic, & Strandberg, 2019; Kohler, Sudharsanan, Bandawe, & Kohler, 2022). Therefore, oyster mushroom is chosen as a functional ingredient in this research because of its high potassium content, which is about 227 mg/100 g of potassium as compared to rice, which has only 38 mg/100 g of potassium. Potassium is a type of electrolyte needed by our bodies. One of the functions of potassium is that it can stretch the tension in the blood vessels to lower blood pressure (Akbar et al., 2022). As a result, this research concluded that in terms of colour, panellists preferred (average score 4.55) instant congee with addition of 1.5 grams of dried oyster mushroom due to its bright colour (relatively light) of congee. Besides, in terms of aroma, panellists preferred instant congee (average score 6.24) with the addition of 4.5 grams of dried oyster mushroom because it produced a strong mushroom aroma (mushroom-scented). Then, in terms of texture, panellists preferred (average score 5.66) instant congee with an addition of 3 grams of dried oyster mushrooms, which made the congee slightly chewy (thick-textured). In terms of taste, panellists chose the instant congee with 3 grams of dried oyster mushroom, which has a savoury taste with an average of 5.26. Lastly, in terms of overall assessment, instant congee with 1.5 grams of dried oyster mushrooms was chosen. As a conclusion, panellists preferred the instant oyster mushroom congee with addition of 1.5 grams of dried oyster mushrooms based on the calculation of the hedonic test data with 79%, whereby it is considered an acceptable and good product that is created as a complete diet for elderly.

A recent study on development of instant fortified porridge by Ngume, Katalambula, Munyogwa, and Mongi (2022) focused on instant complementary food made specifically for infants and toddlers aged between 6 to 23 months in Tanzania. In developing countries like Tanzania, most prepared foods for children are made of cereal, which is high in carbohydrates but low in macro- and micronutrients such as protein, vitamin A, and minerals that are crucial for the development and growth of children. The aim of this study is to produce and evaluate the sensory characteristics of the developed and optimised quale birds' meat-based complementary flour and porridge. It has been demonstrated that bird meat contains a substantial amount of nutrients, such as protein, zinc, and iron (Ngume et al., 2022). Even though it is nutrient-dense, quale birds' meat is underutilized in many dishes. This

indicates that using the meat of quale birds as a functional ingredient can assist people in obtaining their daily nutritional requirements while reducing the rate of child malnutrition in Tanzania. The findings show instant porridge of potatoes mixed with 19% bird meat had higher colour, aroma, viscosity, and smoothness intensities than other samples (i.e., instant porridge of rice mixed with 12% bird meat and banana mixed with 20% bird meat). Meanwhile, for whiteness and sweetness intensity scores, instant porridge of rice mixed with 12% bird meat has the highest scores. In addition, the most acceptable instant porridge based on consumer liking is potatoes mixed with 19% bird meat based on attributes of aroma, smoothness, sweetness, colour, and viscosity.

Instant rice congee has also been explored and developed in a study by Yong et al. (2023). In this study, starch and gum have been added to instant rice congee as a thickening agent to assist individuals with dysphagia in lowering their risk of choking when swallowing. Patients with dysphagia may benefit from this diet recommendation because pureed food is a form of texture-modified food that requires less oral preparation and handling. Moreover, thickener is frequently used during the preparation of pureed foods to attain the desired consistency. According to Wu et al. (2018), higher-viscosity foods aid in longer swallowing durations, which results in a safer swallowing process. Based on this study, peak viscosity of instant rice congee powder increased significantly in the presence of thickener, with gum having a more noticeable impact than starch. Based on the results of sensory evaluation by 20 patients with dysphagia, addition of 1% xanthan gum to instant rice congee has a less sticky texture as compared to instant rice congee with addition of 1% guar gum, 1% sago, and 1% tapioca starch. Probably less sticky, instant rice congee is mainly accepted by the panellists because it is easier to swallow. Furthermore, instant rice congee with 1% xanthan gum has the highest score in overall acceptability rating. To sum up, the development of instant rice congee for patients with dysphagia in this study fulfilled the criteria based on the framework outlined by the International Dysphagia Diet Standardisation Initiative (IDDS). In addition, it was determined that xanthan gum had the best chance of being used to thicken instant rice congee. The efficacy of adding ~~of~~ xanthan gum to instant rice congee may provide a convenient and more affordable alternative to the presently accessible commercial thickener for the treatment of dysphagia.

Table 4. Fortification of functional ingredients in instant porridge and congee.

Functional ingredient	Target consumer	Benefit of porridge and congee	References
Soybean (30%)	Patients with celiac disease	• High antioxidants • High fat and sufficient in supplying essential amino acids	Mayachiew et al. (2015)
Oyster mushroom (1.5%)	Elderly	• High potassium	Akbar et al. (2022)
Quale birds' meat (12-19%)	Infants and toddlers	• High protein, zinc, and iron.	Ngume et al. (2022)
Xanthan gum (1%)	Patients with dysphagia	• High viscosity, aid in swallowing process	Yong et al. (2023)

6. SUBSTITUTION OF FUNCTIONAL INGREDIENTS IN INSTANT PORRIDGE AND CONGEE

Apart from fortification, functional ingredients are also commonly substituted in instant porridge and congee (Table 5). A buckwheat-enriched instant porridge as a functional food to improve lipid profiles and reduce inflammation was produced by Mišan et al. (2017). The development of buckwheat-enriched instant porridge focused on patients with mild to moderate hypercholesterolemia. Buckwheat (39%) is used as a pseudo-cereal in place of maize in the instant porridge formulation due to its excellent nutritional qualities, such as anti-diabetic, anti-hypercholesterolemic, anti-oxidative, anti-cancer, and anti-inflammatory benefits. In addition, buckwheat is also claimed to be helpful for celiac disease patients because it contains no harmful prolamins. According to the outcomes, intake of instant buckwheat porridge with addition of soy protein isolates and casein is claimed to be

capable of enhancing adiponectin, high-density lipoprotein (HDL) cholesterol, and fat-free mass, while serum levels of triacylglycerol, uric acid, total cholesterol, and low-density lipoprotein (LDL) cholesterol were significantly decreased. Thus, it can be concluded that the development of instant buckwheat porridge as a functional food is able to improve lipid profiles and reduce inflammation, which is suitable for patients with mild to moderate hypercholesterolemia. Besides, buckwheat consumption as a component of porridge is a practical and efficient nutritional treatment for enhancing participants' metabolic parameters.

In a study by Sari, Rosidi, Rahmawati, and Candra (2017), instant porridge was developed as a complementary food to breast milk. Up until the age of six months, only breast milk can meet a baby's nutritional needs. As the baby becomes older and heavier, the mother's milk production starts to decline, and the baby's nutritional requirements rise. The control formula in this study consists of only gelatinized corn flour and powdered milk. Therefore, different percentages of snakehead fish meal and pumpkin flour are substituted with corn flour and powdered milk in order to increase the protein and vitamin A content. According to research, in comparison to skim milk, which has a protein level of about 30 g per 100 g, fish meal has a protein content of roughly 60−75 g per 100 g (Sari et al., 2017). Besides, snakehead fish is proven to have a higher protein content, which is about 25.5% as compared to sardines (21.1%), milkfish (20.0%), snapper fish (20.0%), and catfish (17.71%). Pumpkin is preferred as a complementary food source to breast milk due to its high vitamin A and beta-carotene (1.569 µg/100 g) content. According to the organoleptic test done by 15 trained panellists, the best formulas for colour, scent, texture, and flavour were formula A, which is 15% snakehead fish meal and 10% pumpkin flour, and scored 6.3 (slightly yellow), 5.0 for scent (rather strong smell of fish and pumpkin), and 5.0 for texture (rather smooth). Formulas C (20% snakehead fish meal and 10% pumpkin flour) and D (20% snakehead fish meal and 15% pumpkin flour), both of which scored 4.8 on the scale for flavor, were classified as sweetish. To summarize, instant porridge comprising formula A has the potential to provide nutritional requirements while promoting the growth and development of infants older than six months.

Purbowati et al. (2021) developed an instant rice congee that has a similar purpose as Sari et al. (2017). The aim of this research is to produce an instant rice congee as a complementary food for infants aged between 6-24 months in order to meet required nutrition other than breast milk. Red bean is used as a functional ingredient because it is a type of vegetable protein source that can increase the protein content of the rice congee. Furthermore, oyster mushroom is added to the instant rice congee because of its high nutritional content, especially protein, fiber, and iron. Oyster mushrooms also imitate the texture and taste of chicken meat, which could be accepted organoleptically. Besides, red bean and oyster mushroom are local Indonesian foods that are cheap and easy to access. In this study, Purbowati et al. (2021) evaluated the preference and nutritional contents of instant porridge incorporated with red beans and oyster mushrooms. The findings indicate that infants aged 6 to 12 months can get all the nutrients they need from instant porridge made with rice flour and red beans in a 70:30 ratio. This porridge has 156.8% carbs, 24.4% protein, 4.0% fat, and 4.4% fiber. Furthermore, an organoleptic test, also known as a level of preference test, is performed to ascertain the nutritional contents and instant porridge preference using red beans and oyster mushrooms. This test comprises the components of texture, taste, colour, and aroma. The formula that shows the maximum acceptance of an organoleptic test performed by 25 new mothers uses a red bean to rice flour ratio of 70:30. Evidence shows that 90% of respondents enjoyed the porridge's texture, 87% its flavour, 91% its colour, and 88% its aroma. As a conclusion, instant rice porridge with a 70:30 ratio of rice flour to red beans satisfies the nutritional requirements of infants aged 6 to 12 months in terms of carbohydrate, protein, fat, and fiber. It also comes to the best in an organoleptic test as the most appealing formulation.

Not only that, an instant fortified rice congee has been developed with a mixture of pumpkin and brown rice flour (Slamet et al., 2021). Pumpkin is abundant in dietary fiber, and it consists of bioactive compounds such as carotene, vitamin A, and tocopherols, which can be added as a source of nutrients in rice congee. Besides, bran in brown rice is high in fiber content and essential fatty acids. Fiber can prevent gastrointestinal tract disease and

heart disease, which often occur in developing countries such as Indonesia. In addition, the content of essential oils in brown rice reveals that brown rice can reduce serum cholesterol, which is a major risk factor for cardiovascular disease. This research determines the ratio of pumpkin and brown rice as well as the suitable drying temperatures for the development of instant rice porridge. As evidenced by the analysis, it showed that instant porridge is highly influenced by the different mixtures of brown rice and different drying temperatures, based on physical, chemical, and preference characteristics. The optimum ratio of pumpkin and brown rice is 50:50, while the optimum drying temperature is 160 °C. The chemical composition of the optimum instant porridge is 5.62% water, 12.37% protein, 3.70% fat, 1.81% ash, 1,361.79 (mg gallic acid equivalent/g) phenolic, 164.36 (µg/g) beta-carotene, and 41.5% radical scavenging activity antioxidants. The content of phenolic, beta-carotene, and antioxidants shown is relatively high, which is essential for food ingredients in functional foods. To sum up, the instant rice congee that has been produced is suitable for consumers who are in need of a diet high in antioxidants. Antioxidants are proven to reduce the risk of many diseases, including heart disease and certain cancers (Jayaraman et al., 2019).

Table 5. Substitution of functional ingredients in instant porridge and congee.

Functional ingredient	Target consumer	Benefit of porridge and congee	References
Buckwheat (39%) (To substitute maize)	Patients with mild to moderate hypercholesterolemia	• Improve lipid profiles and reduce inflammation	Mišan et al. (2017)
Snakehead fish (15%) + pumpkin flour (10%) (To substitute corn flour + powdered milk)	Infants aged between 6-24 months	• High protein and vitamin A • Promote growth and development of infants	Sari et al. (2017)
Red bean (30%) (To substitute rice flour)	Infants aged between 6-24 months	• High in protein content	Purbowati et al. (2021)
Pumpkin (50%) (To substitute brown rice)	Consumers in need of high antioxidants diet	• High in antioxidants and vitamin A	Slamet et al. (2021)

7. DIFFICULTIES AND ISSUES IN CREATING INSTANT PORRIDGE AND CONGEE

Instant congee or porridge is popular because it is convenient, easy to prepare, affordable, and accessible. However, one of the toughest challenges for all researchers in developing instant congee is the packaging of instant congee. The packaging must be able to retain the nutritional composition and prolong the shelf life of the congee. Furthermore, the packaging should make eating more convenient for consumers. Instant congee is commonly packed in a bowl or cup, like other commercial instant congee on the market, to make it easier to consume immediately from the packaging. Besides, the package should also maintain the proper temperature when warm water is added to improve customers' appetites. Based on the research by Herminiati, Nurfajrina, Achyadi, and Agustina (2021), instant congee products that are packed in aluminums foil have the longest shelf life with the lowest activation energy on protein content parameters, which is 214 days kept at 30°C of storage temperature. Nevertheless, more work is needed to develop packaging for instant congee that focuses on retaining the nutritional composition while maintaining the shelf-life of the products.

Despite the convenience of instant congee, consumer perceptions of the healthiness of processed and instant food are also challenges. Food researchers should create awareness among consumers to choose instant foods that are healthier. Commercial instant congee on the market is claimed to be high in sodium, which contains 1240 mg per package. The sodium content is nearly double the benchmark set by World Health Organization. However, Thailand government has taken an initiative to raise awareness about reducing the level of sodium in instant foods such as instant rice congee among food manufacturers. Chaiyong (2022) reported that instant rice congee produced in 2021 contains less sodium as compared to instant rice congee produced in 2018. As a result, from 6.5% in 2018 to 45.8% in 2021, a greater percentage of instant porridge and instant rice congee products acquired the healthier

choice badge. It shows that the initiative made by the Thailand government towards food manufacturers is successful. The healthier choice badge on the packaging of instant foods will give consumers a good perception of instant food. In addition, a healthier instant rice congee can be made by substituting 35% sodium chloride with soy sauce odour, potassium chloride, and glycine (Sriwattana, Pongsirikul, Siriwoharn, & Chokumnoyporn, 2016). The reduced-sodium instant rice congee contains only about 277–491 mg of sodium per serving as compared to normal instant rice congee, which contains about 662 mg of sodium per serving. Reducing sodium intake in food could benefit consumers by helping them switch to a healthier lifestyle.

8. CONCLUSION

Congee, or porridge, is well-known as an ultimate comfort food as it contains high moisture, which helps in digestion and eases any inflammation in the stomach. Nevertheless, congee or porridge is a starchy food that has low protein content and limited functional ingredients. The nutrients supplied by congee and porridge may not be sufficient for a daily required nutrient intake. Therefore, the development of instant congee or porridge fortified with functional ingredients is an alternative way to develop a food that is convenient and healthy for society. As stated in this review, instant fortified congee and porridge are proven to have higher protein, fat, and ash content. Some of the functional ingredients used can solve the problems faced by patients with dysphagia, celiac disease, and hypercholesterolemia. For instance, the addition of 30% soybeans in congee is able to supply essential amino acids for individuals with celiac disease, and the substitution of 39% buckwheat in place of maize is believed to reduce the lipid profile of people with hypercholesterolemia. Moreover, 1% of xanthan gum is added to rice congee as a thickening agent capable of facilitating the swallowing process. As instant congee may serve as a source of nutrients, especially for the elderly and infants, further research on the incorporation of congee with functional ingredients is needed.

Funding: This work is supported the MyRA Research Grant (Grant number: 600-RMC/GPM ST 5/3 (012/2021)) and Geran Insentif Penyeliaan (Grant number: 600-RMC/GIP 5/3 (114/2022)) awarded by Universiti Teknologi MARA, Malaysia.
Institutional Review Board Statement: Not applicable.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Abhilasha, P., Pal, U., Panda, M., Sahoo, G., Nayak, R., Rayaguru, K., & Sahoo, N. (2021). Standardisation of cooking and conditioning methods for preparation of quick cooking germinated brown rice. *Journal of the Indian Chemical Society*, *98*(8), 100093. https://doi.org/10.1016/j.jics.2021.100093

Akbar, F., Politeknik, Z., Makassar, P., Politeknik, S., & Mahsyar, N. A. (2022). Instant oyster mushroom congee. *Pusaka: Journal of Tourism, Hospitality, Travel and Business Event*, *4*(1), 1–10. https://doi.org/10.33649/pusaka.v4i1.157

Benetos, A., Petrovic, M., & Strandberg, T. (2019). Hypertension management in older and frail older patients. *Circulation Research*, *124*(7), 1045-1060. https://doi.org/10.1161/circresaha.118.313236

Bett-Garber, K. L., Champagne, E. T., Ingram, D. A., & McClung, A. M. (2007). Influence of water-to-rice ratio on cooked rice flavor and texture. *Cereal Chemistry*, *84*(6), 614-619. https://doi.org/10.1094/cchem-84-6-0614

Chaiyong, S. (2022). *The high price of sodium. Bangkok Post.* Retrieved from https://www.bangkokpost.com/life/social-and-lifestyle/2401223/the-high-price-of-sodium

Chen, C., Jiang, S., Li, M., Li, Y., Li, H., Zhao, F., . . . Liu, X. (2021). Effect of high temperature cooking on the quality of rice porridge. *International Journal of Agricultural and Biological Engineering*, *14*(5), 247-254. https://doi.org/10.25165/j.ijabe.20211405.6412

Chysirichote, T., & Phongpipatpong, M. (2015). Effect of sterilizing temperature on physical properties of rice porridge mixed with Legumes and job's tear in retortable pouch. *Journal of Food Processing and Preservation*, *39*(6), 2356-2360. https://doi.org/10.1111/jfpp.12483

Deng, H., Wang, S., Wang, Z., Zhou, Z., & Xiao, H. (2012). Effects of enzyme treatments and drying methods on gelatinization and retrogradation of instant rice porridge. *Food Science and Technology Research*, *18*(3), 341-349. https://doi.org/10.3136/fstr.18.341

Domsa, E. M., Berindan-Neagoe, I., Budisan, L., Braicu, C., Para, I., Tantau, A. I., . . . Andreica, V. (2022). Expression of selected genes and circulating microRNAs in patients with celiac disease. *Medicina (Lithuania)*, *58*(2), 180-200. https://doi.org/10.3390/medicina58020180

Gaikward, G., Sawate, A., Kshirsagar, R., Veer, S., & Mane, R. (2019). Studies on the development and organoleptic evaluation of sweetener-based carrot preserve. *The Pharma Innovation Journal*, *8*(3), 340-343.

Garcia, A., & Da, W. (2011). Nutrition and physical activity of older Chinese immigrants. *Asian Journal of Gerontology & Geriatrics*, *6*(2), 72-81.

Giraud, G. (2013). The world market of fragrant rice, main issues and perspectives. *International Food and Agribusiness Management Review*, *16*(2), 1-20.

Gondal, T. A., Keast, R. S., Shellie, R. A., Jadhav, S. R., Gamlath, S., Mohebbi, M., & Liem, D. G. (2021). Consumer acceptance of brown and white rice varieties. *Foods*, *10*(8), 1-19. https://doi.org/10.3390/foods10081950

Herminiati, A., Nurfajrina, L., Achyadi, N., & Agustina, M. (2021). *The estimation of shelf life of instant porridge in the different packaging with method of accelerated shelf life testing of arrhenius model.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Jayaraman, R., Uluvar, H., Khanum, F., & Singh, V. (2019). Influence of parboiling of red paddy varieties by simple hot soaking on physical, nutrient, phytochemical, antioxidant properties of their dehusked rice and their mineral, starch, and antioxidant's bioaccessibility studies. *Journal of Food Biochemistry*, *43*(7), e12839. https://doi.org/10.1111/jfbc.12839

Jian, O. Z., Utama, A. G. S., Musa, W. N. A. B. W., Hasly, W. B., Al-Rifae, R. F. B., Hussa, N. S. A. B. M., & Andriawan, N. (2021). Effective marketing strategies of McDonald's in Malaysia and Indonesia. *International Journal of Applied Business and International Management*, *6*(2), 33-46. https://doi.org/10.32535/ijabim.v6i2.1167

Juliano, B. O. (2015). Rice: Overview. In: Wrigley, C., Corke, H., and Seetharaman, K., Faubion, J., (eds.) Encyclopedia of Food Grains. In (Vol. 1, pp. 125-129). Oxford: Academic Press.

Juliano, B. O., & Hicks, P. A. (1996). Rice functional properties and rice food products. *Food Reviews International*, *12*(1), 71-103. https://doi.org/10.1080/87559129609541068

Karen, C., Elaine, K., Tuin, E., Ng, F., Xin, W. Y., Lee, Y. S., . . . Hsu, C. (2021). Rice porridge around the world with IDDSI. *IDDSI Special Feature*, *1*(8), 1–8.

Katunzi-Kilewela, A., Mongi, R. J., Kaale, L. D., Kibazohi, O., Fortunatus, R. M., & Rweyemamu, L. M. (2022). Sensory profile, consumer acceptability and preference mapping of cassava-chia seeds composite porridges. *Applied Food Research*, *2*(1), 1–8. https://doi.org/10.1016/j.afres.2021.100038

Keawkaika, S., Suzuki, K., & Hagura, Y. (2010). Determination of viscoelastic properties of rice porridge by the non-rotational concentric cylinder method. *Food Science and Technology Research*, *16*(1), 23-30. https://doi.org/10.3136/fstr.16.23

Khalua, R. K., Tewari, S., Mondal, R., Ranajit, C., & Khalua, K. (2019). Nutritional comparison between brown rice and white rice. *The Pharma Innovation Journal*, *8*(6), 997–998.

Kohler, I. V., Sudharsanan, N., Bandawe, C., & Kohler, H.-P. (2022). Aging and hypertension among the global poor—panel data evidence from Malawi. *PLOS Global Public Health*, *2*(6), e0000600. https://doi.org/10.1371/journal.pgph.0000600

Kowsalya, P., Sharanyakanth, P., & Mahendran, R. (2022). Traditional rice varieties: A comprehensive review on its nutritional, medicinal, therapeutic and health benefit potential. *Journal of Food Composition and Analysis*, *114*, 104742. https://doi.org/10.1016/j.jfca.2022.104742

Li, C., You, Y., Chen, D., Gu, Z., Zhang, Y., Holler, T. P., . . . Li, Z. (2021). A systematic review of rice noodles: Raw material, processing method and quality improvement. *Trends in Food Science & Technology*, *107*, 389-400. https://doi.org/10.1016/j.tifs.2020.11.009

Lina, G., & Min, Z. (2022). Formation and release of cooked rice aroma. *Journal of Cereal Science*, *107*, 103523. https://doi.org/10.1016/j.jcs.2022.103523

Mahgoub, S. A., Mohammed, A. T., & Mobarak, E.-A. (2020). Physiochemical, nutritional and technological properties of instant porridge supplemented with mung bean. *Food and Nutrition Sciences*, *11*(12), 1078-1095. https://doi.org/10.4236/fns.2020.1112076

Malaysian Food Composition Database. (1997). *Rice porridge, fish, instant (Fish Porridge, Instant)*. Retrieved from https://myfcd.moh.gov.my/index.php/1997-food-compositon-database/31-rice-porridge,-fish,-instant-(bubur-ikan,-segera).html

Mayachiew, P., Charunuch, C., & Devahastin, S. (2015). Physicochemical and thermal properties of extruded instant functional rice porridge powder as affected by the addition of soybean or mung bean. *Journal of Food Science*, *80*(12), E2782-E2791. https://doi.org/10.1111/1750-3841.13118

Mir, S. A., Shah, M. A., Bosco, S. J. D., Sunooj, K. V., & Farooq, S. (2020). A review on nutritional properties, shelf life, health aspects, and consumption of brown rice in comparison with white rice. *Cereal Chemistry*, *97*(5), 895-903. https://doi.org/10.1002/cche.10322

Mišan, A., Petelin, A., Stubelj, M., Mandić, A., Šimurina, O., Pojić, M., . . . Pražnikar, Z. J. (2017). Buckwheat–enriched instant porridge improves lipid profile and reduces inflammation in participants with mild to moderate hypercholesterolemia. *Journal of Functional Foods*, *36*, 186-194. https://doi.org/10.1016/j.jff.2017.06.056

Ngume, L., Katalambula, L., Munyogwa, M., & Mongi, R. (2022). Sensory properties, preference mapping and shelf life stability of linear programmed quelea meat based instant complementary food for children aged 6–23 months in Tanzania. *Journal of Agriculture and Food Research*, *10*, 100412. https://doi.org/10.1016/j.jafr.2022.100412

Nguyen, D. H. D., Tran, P. L., Li, D., Han, J.-A., Hwang, J.-Y., Hong, W.-S., . . . Park, J.-T. (2014). Modification of rice grain starch for lump-free cooked rice using thermostable disproportionating enzymes. *Food Research International*, *63*, 55-61. https://doi.org/10.1016/j.foodres.2014.04.007

Noomhorm, A., Kongseree, N., & Apintanapong, M. (1997). Effect of aging on the quality of glutinous rice crackers. *Cereal Chemistry*, *74*(1), 12-15. https://doi.org/10.1094/cchem.1997.74.1.12

Panesar, P. S., & Kaur, S. (2015). Rice: Types and composition. In B. Caballero, P. M. Finglas, & F. Toldrá (Eds.), Encyclopedia of Food and Health. In (1st ed., pp. 646-652). Oxford: Academic Press.

Priya, R. T., Eliazer Nelson, A. R. L., Ravichandran, K., & Antony, U. (2019). Nutritional and functional properties of coloured rice varieties of South India: A review. *Journal of Ethnic Foods*, *6*(1), 1-11. https://doi.org/10.1186/s42779-019-0017-3

Purbowati, P., Wening, D. K., Afiatna, P., Maryanto, S., & Nasifah, I. (2021). *Instant porridge with red beans (Phaseolus vulgaris L) and oyster mushrooms (Pleurotus ostreatus) as A complementary feeding*. Paper presented at the E3S Web of Conferences.

Qiu, S., Abbaspourrad, A., & Padilla-Zakour, O. I. (2021). Changes in the glutinous rice grain and physicochemical properties of its starch upon moderate treatment with pulsed electric field. *Foods*, *10*(2), 395. https://doi.org/10.3390/foods10020395

Rhim, J.-W., Koh, S., & Kim, J.-M. (2011). Effect of freezing temperature on rehydration and water vapor adsorption characteristics of freeze-dried rice porridge. *Journal of Food Engineering*, *104*(4), 484-491. https://doi.org/10.1016/j.jfoodeng.2010.08.010

Roy, P., Shimizu, N., & Kimura, T. (2007). Energy conservation in cooking of milled raw and parboiled rice. *Food Science and Technology Research*, *10*(2), 121-126. https://doi.org/10.3136/fstr.10.121

Sari, D. K., Rosidi, A., Rahmawati, H., & Candra. (2017). Characteristic organoleptic properties of instant baby porridge high in protein and betacarotene. *Pakistan Journal of Nutrition*, *16*(6), 400–405.

Shim, S.-M., & Lim, S.-Y. (2013). Texture properties and radical scavenging ability of porridge products based on beans, grains, and nuts. *Journal of the Korean Society for Applied Biological Chemistry*, *56*(1), 77-82. https://doi.org/10.1007/s13765-012-2219-x

Sieti, N., Rivera, X. C. S., Stamford, L., & Azapagic, A. (2019). Environmental impacts of baby food: Ready-made porridge products. *Journal of Cleaner Production*, *212*, 1554-1567. https://doi.org/10.1016/j.jclepro.2018.12.009

Slamet, A., Kanetro, B., & Setiyoko, A. (2021). The study of physic chemical properties and preference level of instant porridge made of pumpkin and brown rice. *International Journal of Food, Agriculture, and Natural Resources*, *2*(2), 20-26. https://doi.org/10.46676/ij-fanres.v2i2.29

Sriwattana, S., Pongsirikul, I., Siriwoharn, T., & Chokumnoyporn, N. (2016). Strategies for reducing sodium in instant rice porridge and its influence on sensory acceptability. *Chiang Mai University Journal of Natural Sciences*, *15*(3), 203-212.

Sterman, A. (2015). *Congee and the importance of wet, cooked breakfasts. Herbal Medicine Press*. Retrieved from https://anncecilsterman.com/wp-content/uploads/2019/03/Congee-and-the-Importance-of-Wet-Cooked-Breakfasts.pdf

Tang, Y., Cai, W., & Xu, B. (2016). From rice bag to table: Fate of phenolic chemical compositions and antioxidant activities in waxy and non-waxy black rice during home cooking. *Food Chemistry*, *191*, 81-90. https://doi.org/10.1016/j.foodchem.2015.02.001

Thomas, R., Wan-Nadiah, W., & Bhat, R. (2013). Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. *International Food Research Journal*, *20*(3), 1345-1351.

Toleno, R. A. (2017). The celebration of congee in East Asian Buddhism. *Journal of Chinese Buddhist Studies*, *30*(7), 125-168.

Verma, D. K., & Srivastav, P. P. (2020). Bioactive compounds of rice (Oryza sativa L.): Review on paradigm and its potential benefit in human health. *Trends in Food Science & Technology*, *97*, 355-365. https://doi.org/10.1016/j.tifs.2020.01.007

Wang, L., Wang, M., Lv, R., Guo, M., Ye, X., Ding, T., & Liu, D. (2019). Modelling the physical properties change of canned glutinous rice porridge during cooking. *Royal Society of Chemistry Advances*, *9*(10), 5521-5529. https://doi.org/10.1039/c8ra07790h

Wu, S., Chu, L., Liu, C.-F., Zhang, Q., Zhang, Y.-F., Zhou, T.-F., . . . Li, Y. (2018). Effect of changes in bolus viscosity on swallowing muscles in patients with dysphagia after stroke. *Chinese Medical Journal*, *131*(23), 2868-2870.

Yamuangmorn, S., Dell, B., & Prom-U-Thai, C. (2018). Effects of cooking on anthocyanin concentration and bioactive antioxidant capacity in glutinous and non-glutinous purple rice. *Rice Science*, *25*(5), 270-278. https://doi.org/10.1016/j.rsci.2018.04.004

Yong, H.-Y., Abidin, S. Z., Rozalli, N. H. M., & Wahab, N. A. (2023). The effects of different starches and gums on instant pureed rice porridge for patients with dysphagia. *Journal of Food Technology Research*, *10*(1), 11-24. https://doi.org/10.18488/jftr.v10i1.3307

Zhang, J., Li, P., Liu, J., Wang, Y., Zhang, A., Zhao, W., . . . Liu, J. (2022). Nutritional components of millet porridge cooked by different electric cookers based on principal component and cluster analyses. *Foods*, *11*(18), 2823. https://doi.org/10.3390/foods11182823