

Formulation and evaluation of nutritional and sensory properties of porridge from Bangladeshi high-yielding rice varieties

Abstract

Rice provides a vast portion of the daily nutrient requirements of Bangladeshi people as their daily rice intake is high. So, Rice is relatively a better source of vitamins, minerals, protein and starch among cereals for them. The present study was undertaken to formulate porridge added with chicken, fish and vegetables from Bangladesh four high-yielding rice varieties (BRRI dhan29, BRRI dhan34, BRRI dhan50 and BRRI dhan84) and evaluate nutritional (calorie, protein, fat, fiber, calcium, magnesium, iron copper, phosphorus, potassium and sodium) and sensory properties (color and appearance, consistency, taste and flavor and overall acceptability). BRRI dhan34 is aromatic rice and BRRI dhan84 is iron and zinc enriched rice. After the formulation of porridge, nutritional and sensory properties were evaluated. The highest protein content (2.43 ± 0.12 g/100g) was found in the fish with rice recipe formulated with BRRI dhan84 followed by the chicken with rice recipe (2.37 ± 0.10 g/100g). All the recipes formulated with BRRI dhan84 were found to have high protein, iron and zinc content) comparing to their respective recipes. All three recipes had higher nutritional value than control (BRRI dhan29). Overall sensory scores were good enough except for fish with rice recipes. Unexpectedly these recipes were found to have lower sensory scores. The use of coriander leaves or fish smell may be the reason for these low scores. It is recommended to avoid coriander leaves who disfavor its smell. As Bangladesh people consume rice two to three times a day, those porridge recipes may be a good choice for breakfast as well as other meals.

Keywords: Rice porridge, Chicken, Fish, Nutritional value, Sensory evaluation.

Introduction

Nowadays, consumers are expressing a heightened demand for food products that are more healthy, accessible, and natural, without sacrificing health objectives, flavors, or components. Above all else, these food items need to make it easier for customers to manage their busy lives. Porridge 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. Regardless, starchy porridge isn't exactly packed with nutrients. Instead of just eating plain porridge, one may up the nutritional content by adding various beans, grains, and veggies as functional components (Noor et al., 2023). As a semi-fluid food, porridge's viscous texture facilitates chewing, swallowing, and digestion (Gaikward et al., 2019).

Compared to other cereals, rice has more beneficial nutrients, including protein, starch, vitamins, and minerals (Shozib et al., 2018). As a result of the absence of gluten, rice is hypoallergenic (Koo and Lasekan, 2007) and can be used to develop gluten-free hypoallergenic food. Besides, rice-based foods can be the best solution to treat lactose intolerance. Aside from being hypoallergenic, the caryopsis-derived protein from rice has better digestibility and biological value than other grains like corn, wheat, and barley, but lower than proteins from oil crops, legumes, and animals (Day, 2013). In 2023, Bangladesh occupies the position of being the third-largest producer of rice worldwide (Mahmud, 2013). Rice is cultivated in three seasons in Bangladesh: aman, aus, and boro. With a heavy reliance on irrigation and fertilizers, boro is the major paddy producing crop. Aman and aus follow closely after. The high per capita consumption of rice in Bangladesh is a reflection of the fact that the country's population relies on this crop as a mainstay diet. The nutritional demand of the majority of people is met with rice (Ishrat et al., 2016). Bangladeshi people consume rice three times a day. So, rice has a great contribution on their daily calorie intake and overall nutrition. Not only does it make up 97% of all grain output, but it is also vital to the nation's nutrition because adults get half of their daily protein and calories from it (Biswash et al., 2022).

Porridge, being cooked till soft and mushy with a fine texture, is more easily digestible for the body than conventional hard rice. Consuming readily digestible foods such as porridge mitigates bloating, indigestion, and prevents excessive overburden on the stomach. In addition, porridge is a great source of essential nutrients, including rice's carbohydrates, meat's protein, eggs' or oil's fat, veggies' vitamins and minerals, and herbs like ginger. When consumed as a breakfast, it gives you enough energy and nutrition for your daily activities without making you feel bloated, hungry, or nauseous all day. One benefit of porridge is that it can be made in a number of ways to suit individual tastes. It is a versatile dish that may be consumed either plain or completely garnished, appropriate for individuals of all genders and ages, from youngsters to the elderly. Mild porridge recipes are easy to eat. In Bangladesh, Rice porridge is not too much popular as a breakfast cereal. Most of the people consider it as a child food items. But as a rice-producing country, porridge formulation with chicken/fish/vegetables might add dietary diversity besides nutrition in the diet.

Materials and methods

A total of four Bangladeshi rice varieties (BRRI dhan29, BRRI dhan34, BRRI Nghan50, BRRI dhan84) were used for 3 porridge recipe (Chicken with rice, fish with rice and vegetable with rice) formulation. BRRI dhan29 is a widely cultivated variety in Bangladesh. BRRI dhan34 and BRRI dhan50 both are aromatic rice variety released by Bangladesh Rice Research Institute (BRRI). BRRI dhan50 is locally known as “Banglamati”. BRRI dhan84 is a high zing (27.6 mg/kg) and high protein (10.1 mg/kg) containing BRRI variety. All the ingredients except rice were collected from local market (Joydebpur, Gazipur city, Gazipur) at stored at -20°C until use. All the rice varieties used for the porridge formulation were cultivated in BRRI field and after harvesting, dried appropriately and milled (10% polish) in Grain Quality and Nutrition (GQN) Division. Rice samples were dehusked by Satake Rice mill, followed polishing in a Grainman rice polisher.

Formulation of porridge

After collecting all of the ingredients, porridge preparation was started. Ingredients were refrigerated only for a short time needed to collect all of the ingredients. Ingredients needed for porridge formulation are listed in table 1. For rice with chicken recipe, chicken was cut into small pieces and 0.5 teaspoon of soy sauce was added and kept for about 20 minutes. At the time Onion, Ginger and Garlic were peeled and cut into small pieces. After 20 minutes, chicken pieces were fried with Onion, Ginger and Garlic for better flavor and color, and partially blend mix properly with the rice. 50 grams of 10% polished rice was taken in a saucepan and washed. About 800 ml of water was added to the saucepan and started to cook. After 15 minutes, previously fried and partially blended chicken was added to the rice. After 25 minutes, cooking was completed. Throughout the cooking time, porridge was stirred with a stirrer min to increase the texture and not to set down to the saucepan. For fish recipe, same cooking method was followed except addition of coriander leaves and tomatoes. These were added to the rice after 20 minutes of cooking. The fishbone was separated manually before blending. Vegetables were fried in soybean oil are added to the rice and lentils after 15 minutes of cooking followed the same cooking method.

Table 1: List of ingredients for porridge preparation.

Ingredients	Rice + chicken	Rice + fish	Rice + vegetables	Control
Rice (10% polished) (g)	50	50	50	50
Chicken (g)	15	-	-	-
Fish (Rui) (g)	-	15	-	-
Carrot (g)	-	-	5	-
Red amaranth (g)	-	-	5	-
Sweet pumpkin (g)	-	-	5	-

Lentils (g)	-	-	5	-
Tomato	-	5	-	-
Coriander leaves	-	3	-	-
Green pepper (g)	-	-	2	-
Onion (g)	2	2	2	-
Ginger (g)	2	2	-	-
Garlic (g)	2	-	-	-
Soy sauce (teaspoon)	0.5	0.5	-	-
Soybean oil (ml)	2	3	3	-
Salt	As per need	As per need	As per need	As per need

Determination of nutritional value of porridge

Standard protocol was used to test the chemical composition of the porridge. Crude fat, fiber, and carbohydrate were analyzed by following the AOAC method (2005). Crude fiber was obtained after sample digestion with diluted acid, alkali and alcohol. Moisture was determined from sample weight loss after drying at 105° C until constant weight. Protein content was determined by Micro Kjeldahl method and carbohydrates were calculated by difference method.

Mineral profiling: 0.2 g sample with 7 ml HNO₃ and 1 ml H₂O₂ was digested in a microwave digester. After digestion, final volume was made 50 ml with deionized water and estimation was done by ICPOES (ICPE-9020, Shimadzu, Japan) (Erik et al., 2017).

Sensory evaluation

A panel of five seasoned individuals were presented with prepared foods for organoleptic evaluation. Using a hedonic scale-based scorecard of nine points, the panel members evaluated the product (Srilakshmi, 2007)

Results and discussion

Nutritional properties

A total of thirteen porridge recipes (with control) were prepared. Among the chicken with rice recipe, porridge prepared with BRR1 dhan84 was found to have the highest protein (2.37±0.10g/100g) and zinc (0.73±0.05g/100g) content followed by BRR1 dhan34 (protein: 2.16±0.04g/100g; zinc: 0.56±0.03g/100). BRR1 dhan84 is a high-protein and high-zinc-containing variety. Among the fish with rice recipes, porridge from BRR1 dhan84 had the highest protein content (2.43±0.12g/100g) followed by BRR1 dhan34 (2.28±0.07g/100g). All of the vegetable-with-rice recipes had comparatively lower protein content. This is due to the absence of any animal protein source(s) in those recipes. But all the vegetable with rice recipes were found to have higher fat (12.08±0.10 to 12.71±0.12g/100g) and higher fiber (0.22±0.01 to 0.52±0.05g/100g) than the other two recipes. The chicken with rice recipe had the lowest fiber

content (0.05 ± 0.00 to 0.11 ± 0.01 g/100g) than other recipes whereas the control recipe had only 0.07 ± 0.00 g fiber content.

Iron (Fe) is an essential micronutrient for all organisms. Enzymes that synthesize collagen and certain neurotransmitters contain it, and it is an integral part of proteins that are necessary for respiration and energy metabolism. The effective functioning of the immune system also requires iron. The correct operation of all living things depends on microelements such as iron, copper (Cu), and zinc (Zn). These elements are involved in protein synthesis, affect gene expression, impact enzyme function, and contribute to cellular metabolism, antioxidant and anti-inflammatory defenses, and many more processes.

Chicken with BRRRI dhan84 recipe had the highest iron content (0.47 ± 0.02 mg per 100g). All the chicken recipes were found to have high iron content. Interestingly, vegetable with rice recipes had higher iron content than fish with rice recipes. This is due to the addition of iron-rich vegetable sources in porridge although their bioavailability is lower than animal sources. BRRRI dhan84 can be a good source of iron and zinc for Bangladeshi people as their daily rice consumption is 328.92g (HIES 2022). Calcium and Magnesium content was found having higher in vegetables with rice recipes. We know that vegetables are a good source of magnesium. The highest magnesium content was found in Vegetables with BRRRI dhan29 recipe (7.05 ± 0.06 mg/100g) followed by BRRRI dhan34 (6.99 ± 0.03 mg/100g).

Magnesium is essential for proper brain function and mood regulation; insufficient levels have been associated with an elevated risk of major depressive disorder. Research suggests that magnesium deficiency, experienced by over half of all type 2 diabetics, may hinder the body's capacity to control blood sugar levels (Veronese, 2021).

Phosphorus was higher in chicken with rice recipes than in others (9.21 ± 0.02 to 9.51 ± 0.43 mg/100g). In addition to helping the bones grow stronger and more dense, phosphorus also helps the muscles contract and recuperate from activity, and it filters and eliminates waste from the kidneys. Higher potassium content was found in vegetables with rice recipes followed by fish with rice and chicken with rice recipes (28.33 ± 0.33 to 28.64 ± 0.08 vs 25.28 ± 1.44 to 26.95 ± 1.00 vs 22.11 ± 0.10 to 22.41 ± 0.24 mg/100g). On the other hand, zinc content was higher for all Recipes with BRRRI dhan84 as it is a high zinc variety. The control (BRRRI dhan29) recipe was found to have much less amount of all parameters except total energy and carbohydrates (Table 2 and Table 3).

Table 2: Nutritional properties of formulated porridge(per 100g porridge).

Recipe	Rice variety	Energy (Kcal)	Protein (g)	Fat (g)	CHO (g)	Total Dietary Fiber (g)
Chicken- rice	BRR1 dhan29	66.11±1.24	1.89±0.15	1.26±0.05	11.87±0.05	0.11±0.01
	BRR1 dhan34	63.48±0.56	2.16±0.04	1.23±0.01	11.94±0.22	0.06±0.01
	BRR1 dhan50	67.97±0.75	1.99±0.11	1.22±0.01	11.74±0.09	0.05±0.00
	BRR1 dhan84	70.43±0.54	2.37±0.10	1.26±0.02	11.98±0.08	0.06±0.01
Fish-rice	BRR1 dhan29	64.61±1.01	2.05±0.08	1.08±0.02	11.92±0.09	0.27±0.01
	BRR1 dhan34	62.57±1.27	2.28±0.07	1.10±0.01	11.73±0.22	0.24±0.04
	BRR1 dhan50	64.81±0.70	2.07±0.08	1.08±0.01	11.58±0.16	0.22±0.01
	BRR1 dhan84	66.21±1.21	2.43±0.12	1.08±0.03	11.96±0.15	0.21±0.00
Vegetable- rice	BRR1 dhan29	68.51±0.77	1.79±0.05	1.12±0.00	12.08±0.10	0.22±0.01
	BRR1 dhan34	63.99±2.24	1.71±0.11	1.00±0.02	12.33±0.07	0.52±0.05
	BRR1 dhan50	65.25±1.49	1.78±0.08	1.01±0.01	12.62±0.20	0.49±0.01
	BRR1 dhan84	69.36±1.30	1.99±0.06	1.00±0.02	12.71±0.12	0.50±0.01
Control (BRR1 dhan29)		56.77±2.67	1.19±0.03	0.16±0.00	11.78±1.68	0.07±0.00
NB: All the data are average of triplicate results ± Standard deviation.						

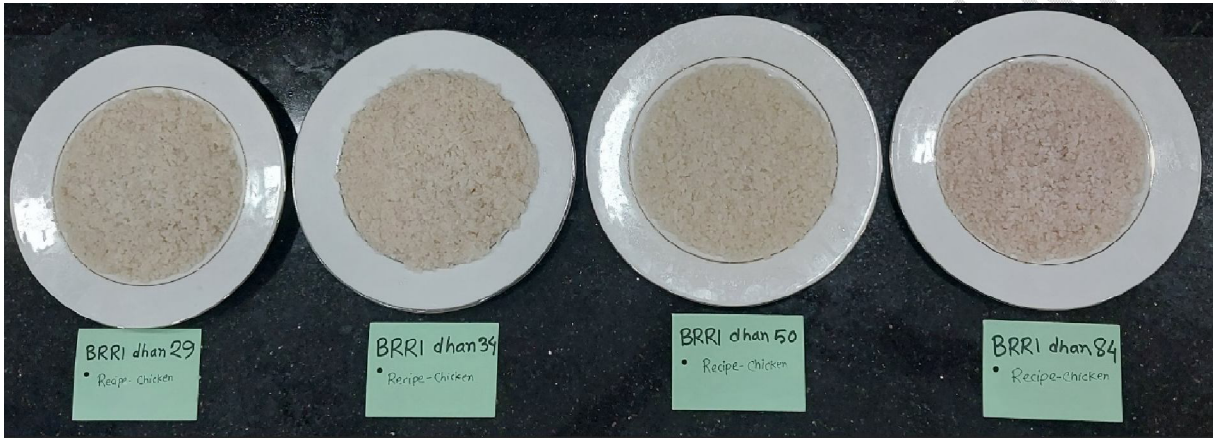
Table 3: Mineral profile of formulated porridge recipes (per 100g porridge).

Recipe		Ca (mg)	Fe (mg)	Mg (mg)	P (mg)	K (mg)	Na (mg)	Zn (mg)	Cu (mg)
Chicken-rice	BRI dhan29	1.80±0.01	0.39±0.00	4.06±0.05	9.51±0.43	22.11±0.10	34.68±0.16	0.54±0.01	0.01±0.00
	BRI dhan34	1.93±0.02	0.38±0.01	4.01±0.03	9.25±0.05	22.41±0.24	34.63±0.09	0.56±0.03	0.01±0.00
	BRI dhan50	1.79±0.04	0.34±0.02	2.29±0.05	9.21±0.02	22.15±0.15	34.09±0.60	0.53±0.02	0.02±0.00
	BRI dhan84	1.77±0.08	0.47±0.02	2.23±0.03	9.32±0.08	22.31±0.18	35.58±1.24	0.73±0.05	0.01±0.00
Fish-rice	BRI dhan29	5.90±0.10	0.23±0.01	5.56±0.06	8.53±0.06	26.61±0.54	33.67±0.59	0.45±0.01	0.02±0.00
	BRI dhan34	6.04±0.06	0.23±0.01	5.54±0.05	8.58±0.11	26.83±0.76	34.66±1.06	0.45±0.03	0.01±0.00
	BRI dhan50	5.98±0.04	0.25±0.02	3.82±0.04	8.54±0.06	25.28±1.44	34.37±0.55	0.42±0.03	0.01±0.00
	BRI dhan84	5.97±0.03	0.31±0.03	3.82±0.02	8.54±0.05	26.95±1.00	35.70±1.47	0.630.04	0.01±0.01
Vegetable-rice	BRI dhan29	8.09±0.16	0.36±0.02	7.05±0.06	2.71±0.02	28.33±0.33	2.59±0.28	0.33±0.05	0.01±0.00
	BRI dhan34	8.47±0.12	0.36±0.02	6.99±0.03	2.74±0.03	28.53±0.11	2.57±0.09	0.27±0.03	0.03±0.01
	BRI dhan50	8.29±0.08	0.36±0.01	5.23±0.01	2.72±0.02	28.590.08	2.55±0.05	0.27±0.02	0.03±0.00
	BRI dhan84	8.39±0.09	0.42±0.02	5.20±0.03	2.67±0.11	28.64±0.08	2.60±0.01	0.47±0.02	0.03±0.00
Control (BRI dhan29)		0.52±0.03	0.09±0.00	2.20±0.17	0.03±0.00	-	-	0.26±0.02	-
NB: All the data are average of triplicate results ± Standard deviation.									

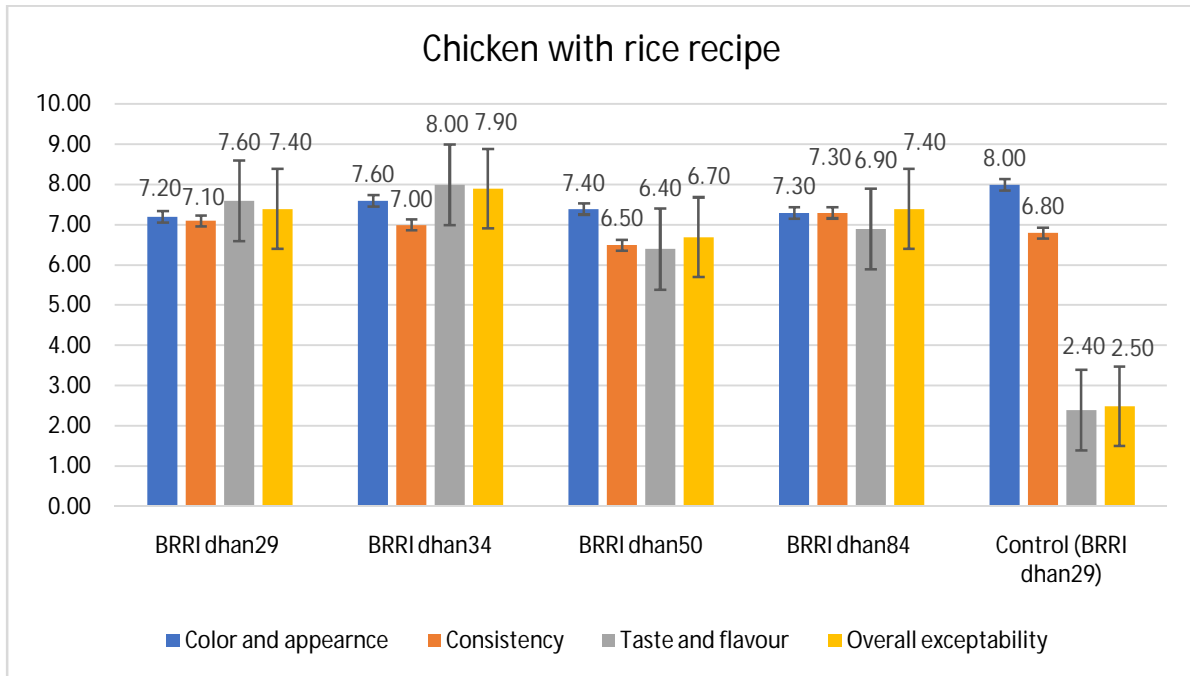
Sensory evaluation

When it comes to food quality, color is the most essential aesthetic attribute, particularly when it pairs with other characteristics. It not only gives an idea of how fresh and tasty the goods will be, but it can also affect the buyer's decision and satisfaction. A big factor in food consumption is the pleasurable sensory experience of eating certain meals. Foods that appeal to the sense of taste (via aroma, color, texture, and other sensory perceptions) may help in both enjoying one's meal more and feeling full after eating less. The food processing business relies heavily on aromas and flavors. Some foods have a strong, undesirable smell, but adding flavors and scents can cover it up, making the dish taste better and making it more appealing to consumers.

A porridge's sensory quality was determined by how it tasted, looked, felt, and was generally accepted. Among chicken recipes, porridge prepared from BRR1 dhan34 has the highest overall acceptability score followed by BRR1 dhan84 and BRR1 dhan29. BRR1 dhan34 is a popular rice variety in Bangladesh because of its aroma and small pericarp. The aroma of BRR1 dhan34 is the factor that affects the overall acceptability in sensory evaluation. The aroma of rice added extra attractive flavor to the porridge. Besides it affects the overall texture of the porridge. All the fish-rice recipes have obtained lower sensory scores. This may be due to disfavor the fish smell or coriander leaves. Coriander leaves are popularly used in vegetable and fish recipes due to its flavor. It is not uncommon finding people disfavoring coriander leaves as they can't tolerate/dislike it. In this case, we recommend avoiding this item in porridge. BRR1 dhan84 has red-colored pericarp and its appearance score was good enough. All of the vegetable recipes have a better sensory parameter score. Lentils in this recipe has added extra texture as well as color and made porridge overlook the deficiency of amino acid lysine. The addition of chicken and fish sources was to provide some animal sources of nutrients to make the porridge more nutritious. Besides chicken and fish also contributed to the color, taste and texture of the porridge to make it more acceptable to the consumer.

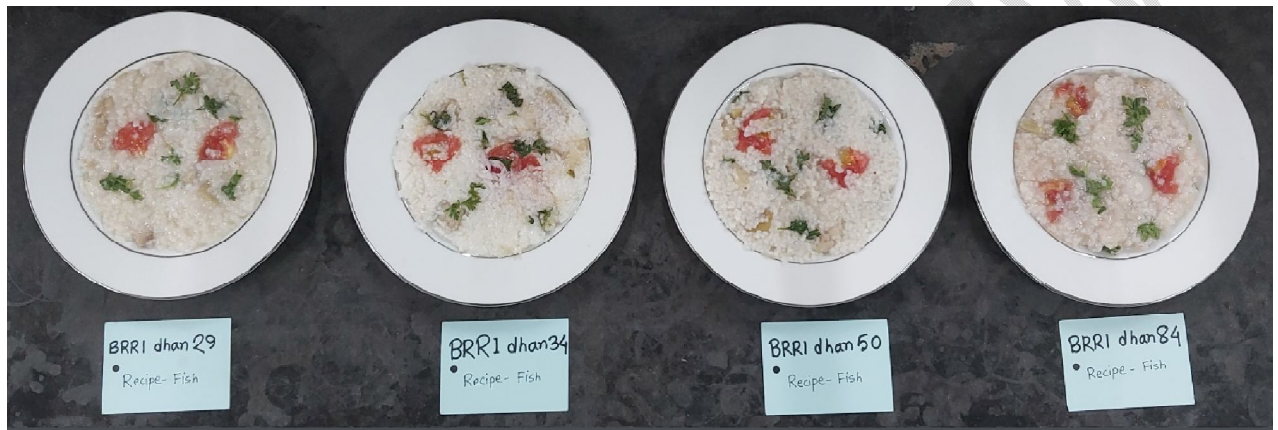


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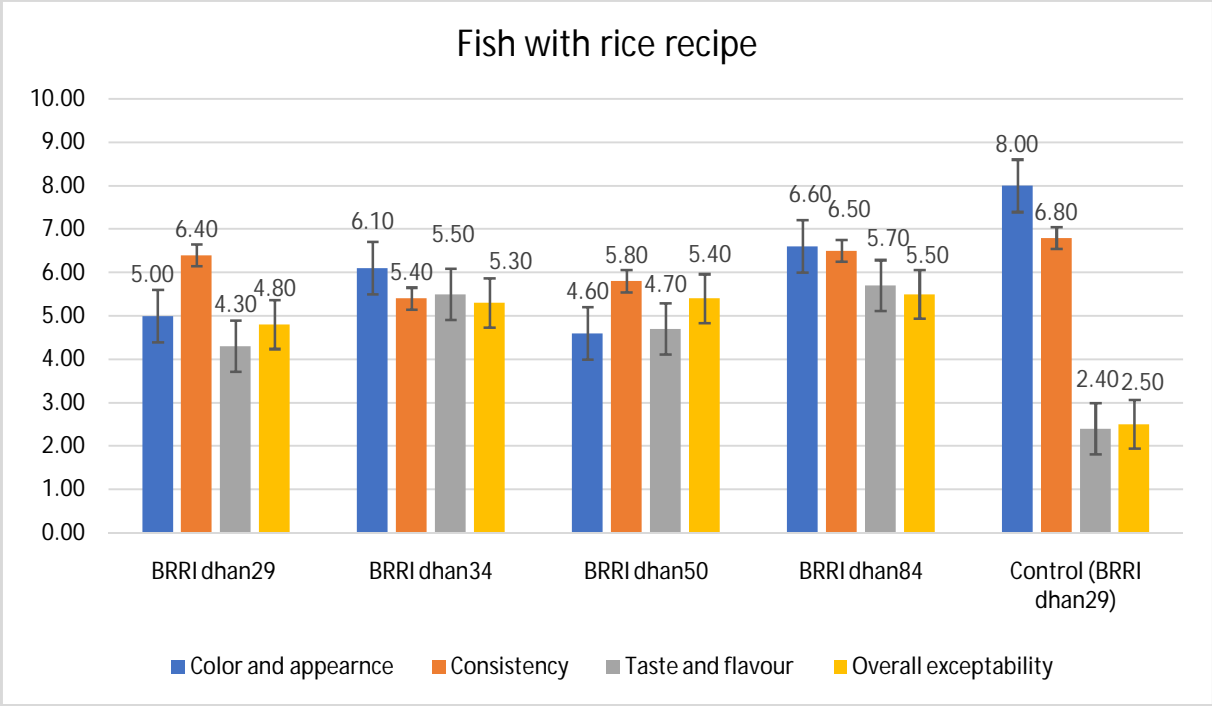


(b)

Figure 1: (a) Chicken with rice porridge; (b) Sensory scores of chickenwith rice porridge.



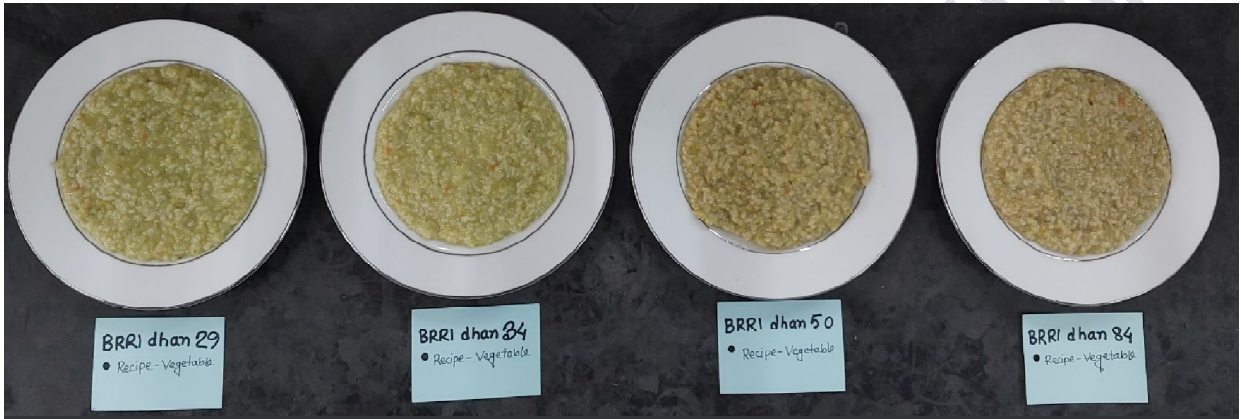
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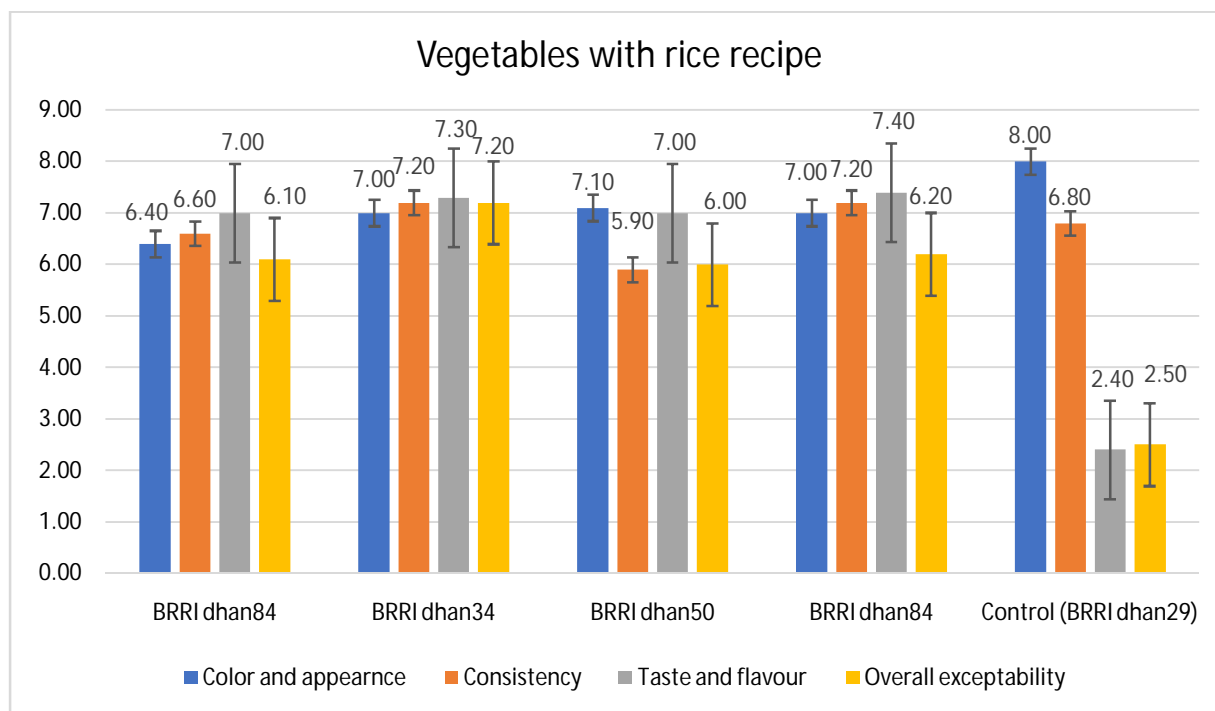
(b)

Figure 2: (a) Fish with rice porridge; (b) Sensory scores of fish with rice porridge.

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(a)



(b)

Figure 3: (a) Vegetables with rice porridge; (b) Sensory scores of vegetables with rice porridge.

Conclusion

Porridge is well known for being a nutritious dish that is simple to prepare and easy to digest. The time-saving rice porridge formulation recipes of this study may be a good choice for Bangladeshi people to diversify their rice-based meals and add extra nutrients to their food items easily.

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