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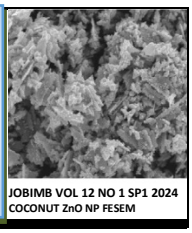

Effect of Rice Bran Incorporation on the Texture Profile and Physicochemical Properties of Fresh Pasta

Lau Cai Ling[1] and Nor Akma Ismail[1]*

[1]Department of Food Technology, Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.

*Corresponding author:
Dr Nor Akma Ismail,
Department of Food Technology,
Faculty of Fisheries and Food Science,
Universiti Malaysia Terengganu,
21030 Kuala Nerus,
Terengganu,
Malaysia.
Email: akma.ismail@umt.edu.my

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ABSTRACT

Rice bran (RB) contains significant amounts of nutrients. RB's nutritious and low price makes it highly interesting to be added to food formulation. The study aims to investigate the effect of the addition of edible RB to the fresh pasta (Fettuccine). Four RB levels (5%, 10%, 15%, and 20%) were chosen to substitute durum semolina content in the fresh pasta formulations. The results indicate that the addition of RB increased the darkness and redness of the pasta. The texture of the pasta was influenced by the addition of RB where increased hardness, adhesiveness, gumminess, and chewiness were observed as the amount of RB increased, while the cohesiveness and resilience showed a decreased trend. Results showed a decrease in carbohydrate (49-59%), while an increase in crude protein (9.63-10.16%), crude fiber (0.31-2.64%), crude fat (0.01-4.99%), and ash (0.77–2.06%) of the pasta. In conclusion, the use of RB to replace durum wheat semolina altered the cooking quality, improved some nutritional composition, and obtained high acceptability of RB fresh pasta.

INTRODUCTION

Pasta, a significant component of human nutrition due to its rich complex carbohydrates, primarily consists of wheat flour and water [1, 2]. Durum wheat semolina is widely recognized as the optimal ingredient for traditional pasta [3]. Traditional pasta often lacks nutrients, typically comprising only wheat flour and water [4]. Kaur et al. [5] proposed creating dietetic pasta by enriching durum wheat semolina with cereal bran to address this, enhancing dietary fiber and protein content. Utilizing RB (RB) for dietary fiber addition presents an opportunity for value-added food, as observed in various products like bread, cakes, noodles, and ice creams without compromising their functional and textural qualities [6]. While previous studies have explored the addition of RB to dry pasta leading to nutritional value and antioxidant characteristics enhancement [7], limited research has focused on the impact of rice bran fiber (RBF) on the qualities of fresh pasta. Thus, this study aims to investigate the cooking quality, physicochemical properties, and sensory acceptance of fresh pasta (Fettuccine) incorporated with varying amounts of RB

MATERIALS AND METHODS

Chemicals and materials

Commercial durum wheat semolina (Granoro Extra Durum Wheat Semolina, Italy) was purchased from an online shopee in Malaysia. Rice bran (Spektrum, Pulau Pinang, Malaysia) was purchased from the online market Lazada in Malaysia. Salt was purchased from the local supermarket. All chemicals and reagents employed in the study were of analytical grade.

Fresh pasta preparation

Fresh pasta was prepared following the protocol outlined by Ajila et al. [8]. The essential components included 500 g of semolina wheat flour, 180 ml of water, and 3 g of salt. The control pasta consisted of 100% semolina flour. Four additional pasta variations were created by substituting semolina flour with 5%, 10%, 15%, and 20% stabilized RB flour. The warm (40 ± 2 °C) distilled water (180 ml) and salt were blended, followed by the manual kneading of semolina wheat flour and rice bran flour.

The resulting dough was shaped into small lumps, rolled through a noodle machine, and cut into 20 cm strands to produce fresh fettuccine. The formulation of pasta was calculated using the correct amount, as shown in **Table 1**.

Table 1. Formulation of pasta making process.

Ingredient	A (0% RB) (g)	B (5% RB) (g)	C (10% RB) (g)	D (15% RB) (g)	E (20% RB) (g)
Durum wheat semolina flour	500	475	450	425	400
RB	0	25	50	75	100
Water	180	180	180	180	180
Salt	3	3	3	3	3
Total	683	683	683	683	683

Physical properties

The texture profile characteristics were analyzed by using a texture analyzer (TA-xT2i, Stable Micro Systems, Godalming, U.K.) equipped with a 36 mm cylinder probe with radius (P/36R) and a 5kg load cell followed the method described by Foo et al. [9]. The color was measured using a Chromameter CR-400 (Konica Minolta, Tokyo, Japan) equipped with a D65 illuminant, following the CIE Lab* system [4]. ΔE was calculated to determine the alteration in the colour of samples and control, the following equation:

$$\Delta E = \sqrt{(\Delta L)^2+(\Delta a)^2+(\Delta b)^2}$$

Chemical analysis

The cooked pasta was dried at room temperature and chopped to a fine particle using a knife and chopping board to obtain a small volume and larger surface area sample. Standard methods, including moisture content [10], crude ash [11], crude fat (ether extract) [12], crude protein [11], crude fiber [10], and crude carbohydrate were determined by difference.

Statistical analysis

Data were expressed as means ± standard deviations (S.D.) by one-way analysis of variance (ANOVA) using Tukey's tests, Minitab 21 statistical software where probability ($p<0.05$) was considered statistically significant.

RESULT AND DISCUSSION

Physical properties

Table 2 illustrates the Texture Profile Analysis (TPA) of cooked pasta. A significant ($p<0.05$) increase was observed comparing control pasta and RB pasta in all TPA parameters but decreased in cohesiveness and resilience. There was no significant difference (p>0.05) between the springiness samples.

Colour

Table 3 shows the colour of fresh pasta prepared. Increased in RB flour levels from 5% to 20%, the pasta darkened, exhibiting a shift towards redder and bluer tones. The L* value notably decreased ($p < 0.05$) from 71.62 to 50.39, accompanied by an increase ($p< 0.05$) in a* values from -0.54 to 5.18. A significant decrease ($p < 0.05$) in b* value indicated diminished yellowness in pasta with higher RB levels (5%-20%). The ΔE values revealed distinguishable variations between cooked samples, with a difference of more than 5 units, making them discernible to the human eye [13]. These findings are visually supported by **Fig. 1**, which illustrates the colour differences in fresh pasta formulations.

Table 3. Colour values of RB pasta with different formulations (denominated from A-E). A - Pasta with (0% wheat flour, 100% RB); B - Pasta with (95% wheat flour, 5% RB); C - Pasta with (90% wheat flour, 10% RB); D - Pasta with (85% wheat flour, 15% RB); E - Pasta with (80% wheat flour, 20% RB). Values are expressed as mean ± S.D. of triplicate measurement with different superscript letters, which are significantly different at $p < 0.05$ in the same column.

Formulation	Colour Profile			
	L* Value	a* Value	b* Value	ΔE
A (0% RB)	71.62 ± 0.21^{a}	-5.04 ± 0.05^{e}	20.00 ± 0.59^{e}	
B (5% RB)	65.52 ± 0.11^{b}	0.22 ± 0.13^{d}	23.50 ± 0.16^{a}	8.80 ± 0.44^{d}
C (10% RB)	59.08 ± 0.11^{c}	2.05 ± 0.17^{c}	22.03 ± 0.42^{b}	14.55 ± 0.19^{c}
D (15% RB)	51.55 ± 0.09^{d}	3.91 ± 0.09^{b}	21.12 ± 0.20^{b}	22.02 ± 0.30^{b}
E (20% RB)	50.39 ± 0.38^{e}	5.18 ± 0.05^{a}	20.18 ± 0.07^{c}	23.57 ± 0.28^{a}

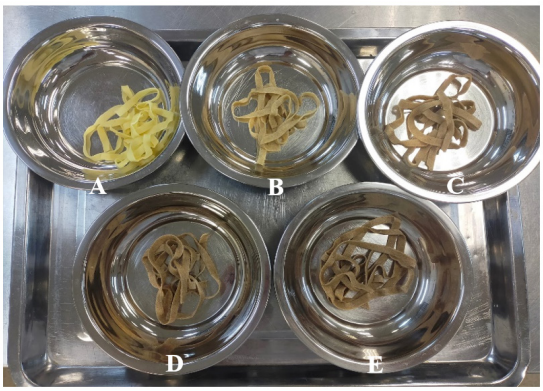

Fig. 1. Fresh pasta incorporated with different percentages of RB A - Pasta with (0% wheat flour, 100% RB); B - Pasta with (95% wheat flour, 5% RB); C - Pasta with (90% wheat flour, 10% RB); D - Pasta with (85% wheat flour, 15% RB); E - Pasta with (80% wheat flour, 20% RB).

Table 2. Texture profile values (n=3) of RB pasta with different formulations (denominated from A-E). A - Pasta with (0% wheat flour, 100% RB); B - Pasta with (95% wheat flour, 5% RB); C - Pasta with (90% wheat flour, 10% RB); D - Pasta with (85% wheat flour, 15% RB); E - Pasta with (80% wheat flour, 20% RB). Values are expressed as mean ± S.D. of triplicate measurement with different superscript letters, which are significantly different at $p < 0.05$ in the same row.

Attributes	RB pasta				
	A	B	C	D	E
Hardness	3839.80 ± 160.90^{d}	4302.30 ± 157.80^{c}	4523.80 ± 45.40^{bc}	4668.20 ± 60.10^{ab}	4926.80 ± 80.00^{a}
Adhesiveness	-262.51 ± 59.41^{b}	-221.77 ± 30.04^{ab}	-173.52 ± 14.07^{ab}	-155.94 ± 30.87^{a}	-164.29 ± 24.11^{a}
Springiness	0.75 ± 0.06^{a}	0.73 ± 0.07^{a}	0.83 ± 0.03^{a}	0.81 ± 0.04^{a}	0.78 ± 0.05^{a}
Cohesiveness	0.96 ± 0.01^{a}	0.95 ± 0.01^{ab}	0.93 ± 0.01^{abc}	0.93 ± 0.01^{bc}	0.92 ± 0.01^{c}
Chewiness	2761.00 ± 246.00^{b}	2966.00 ± 351.00^{ab}	3471.30 ± 71.70^{a}	3535.80 ± 165.50^{a}	3534.00 ± 246.00^{a}
Gumminess	3686.20 ± 125.80^{d}	4085.20 ± 137.70^{c}	4195.80 ± 99.50^{bc}	4351.2 ± 45.7^{ab}	4531.90 ± 34.40^{a}
Resilience	1.13 ± 0.03^{a}	1.08 ± 0.05^{ab}	0.98 ± 0.06^{b}	1.02 ± 0.01^{b}	0.99 ± 0.03^{b}

Table 4. Proximate analysis values of RB pasta with different formulations (denominated from A-E). A - Pasta with (0% wheat flour, 100% RB); B - Pasta with (95% wheat flour, 5% RB); C - Pasta with (90% wheat flour, 10% RB); D - Pasta with (85% wheat flour, 15% RB); E - Pasta with (80% wheat flour, 20% RB). Values are expressed as mean ± S.D. of duplicate measurements with different superscript letters which are significantly different at $p < 0.05$ in the same row.

Attributes	RB pasta				
	A	B	C	D	E
Moisture content	30.27 ± 0.01^{d}	31.21 ± 0.05^{b}	32.09 ± 0.00^{a}	31.83 ± 0.00^{a}	30.62 ± 0.18^{c}
Ash	0.77 ± 0.00^{e}	1.04 ± 0.01^{d}	1.37 ± 0.01^{c}	1.68 ± 0.00^{b}	2.06 ± 0.01^{a}
Crude fat	0.02 ± 0.02^{b}	0.65 ± 0.46^{b}	3.54 ± 1.35^{a}	3.52 ± 0.23^{a}	4.99 ± 0.06^{a}
Crude protein	9.63 ± 0.14^{a}	9.86 ± 0.08^{a}	9.90 ± 0.11^{a}	10.05 ± 0.42^{a}	10.16 ± 0.16^{a}
Crude fiber	0.31 ± 0.09^{b}	0.62 ± 0.76^{b}	0.98 ± 0.27^{b}	1.79 ± 0.17^{ab}	2.64 ± 0.25^{a}
Crude carbohydrate	59.00 ± 0.21^{a}	56.62 ± 0.44^{b}	52.13 ± 1.19^{c}	51.13 ± 0.03^{cd}	49.53 ± 0.16^{d}

Chemical properties

Table 4 presents the proximate analysis of the fresh pasta prepared. Moisture content increased from 31.21% to 31.83% as the RB percentages rose from 5% to 15% (samples B-D) compared to the control (sample A). However, with 20% RB (sample E), the moisture content decreased to 30.62%, aligning with findings by Begum et al. [14] for RB noodles. The higher nutrient content of RB (ash, protein, fat, and fiber) compared to durum semolina flour justified their inclusion in fresh pasta, enhancing its nutritional value. Carbohydrates, the main pasta component, significantly decreased ($p < 0.05$) from 59.0% to 49.53%. The study noted a slight increase in crude protein content (0.02% to 0.24%) with no significant difference ($p > 0.05$) among samples.

CONCLUSION

The colour of RB pasta increased its darkness and red intensity colour. The texture attributes, hardness, adhesiveness, gumminess, and chewiness, increased as the amount of RB flour was added to the fresh pasta, except for cohesiveness and resilience, which showed a decrease in value. Incorporating RB improved the pasta's nutritional properties, including minerals(ash), protein, fat, and fiber, but decreased carbohydrates. The result is proven by the study of RB, an accessible and inexpensive rich nutrient material that could be used in nutritionally improved pasta.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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