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Research Article

Analyzing quality characteristics of texturized vegetable protein using defatted soy flour with rice flour and rice starch

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Abstract This study analyzed the quality of texturized vegetable protein (TVP) made from defatted soy flour combined with flour or starch from rice sources. The base raw material formulation consisted of 50% soybean protein, 30% gluten, and 20% rice flour and rice starch. A cooling die-equipped extruder was used with a barrel temperature of 190℃ and screw rotation speed of 250 rpm. The hardness and cutting strength of the extruded TVP were found to be higher for white rice than for glutinous rice and higher for flour than for starch. Gumminess and chewiness were similar across rice types, but higher for flour than for starch. White rice TVP had a lower water absorption capacity than glutinous rice TVP. Turbidity was lowest for white rice flour and highest for corn starch. Using rice flour instead of starch in TVP production can simplify processing and contribute to promoting the consumption of rice.

Keywords TVP, extrusion, defatted soy flour, rice, texturization

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1. Introduction

The global market for meat substitutes is witnessing a significant expansion amidst intensifying environmental problems, such as climate change caused by greenhouse gas emissions, coupled with a burgeoning vegetarian movement. The Business Research Company (2023) reported a robust growth trajectory for the global alternative food sector, with a projected annual growth rate of 15.1%, escalating from USD 8.14 billion in 2022 to 16.42 billion by 2027. In the South Korean market, the dominance of plant-based protein products, particularly those derived from soybeans, marks a significant trend in the alternative food sector. According to Euromonitor's 2022 analysis, the South Korean market for plant protein-based alternative foods reached a valuation of KRW 21.2 billion, registering an impressive year-over-year growth of 28.3%. These plant protein-based alternative food products primarily utilize texturized vegetable protein (TVP) produced by extrusion. Consequently, intensive research efforts are now focused on developing TVP with textures emulating meat. The qualitative attributes of TVP are determined by various factors, including the type and formulation of raw materials, moisture content, extrusion pressure, and temperature settings, along with the incorporation of additives to enhance texture and flavor profiles (Park et al., 2023).

Sources of protein include soy protein, wheat protein, pea protein, and seeds such as canola and sunflower seeds, as well as peanut, rice, and mung bean protein (Cho and Ryu, 2021; Samard and Ryu, 2019). The most common protein source in the country is soy protein, which is used in the form of isolated soy protein, concentrated soy protein, and defatted soy flour. Isolated soy protein

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and concentrated soy protein have high protein content, which leads to good texturization during extrusion. However, the process of isolating and purifying protein from soybeans is complex. On the other hand, defatted soy flour is advantageous because its processing only requires defatting through pressing without the need for complex separation and purification steps. However, its lower protein content results in poor texturization (Park et al., 2023). The higher the protein concentration, the firmer the product becomes (Saio, 1987), and the type and content of plant proteins affect the physicochemical and functional quality of the final product (Choi and Chin, 2020).

Meanwhile, common starch sources include wheat, corn, potato, rice, and tapioca starch. The type of starch material influence the texturization of extruded products. Considering this, Zhang et al. (2016) reported that the use of wheat and corn starch influences the characteristics of the extrudate due to the thermal transition properties of the starch that affect the extrusion parameters. However, the starch extraction process from grains can have a negative environmental impact. Therefore, it is important to select raw materials that can maintain quality with less or no refining. Rice, with over 60% of its weight consisting of starch, is also used as a food additive to provide texture (You et al., 2014). White rice starch is composed of 20% amylose and 80% amylopectin, while glutinous rice starch is nearly 100% amylopectin (Lee et al., 2004). In Korea, per capita rice consumption has been continuously decreasing since 1979 (59.2 kg as of 2019) (Jo et al., 2020). However, due to oversupply issues in the domestic rice market, in part due to free trade agreements (Choi, 2002), long-term measures should be taken to promote rice consumption (Han et al., 2012).

In this context, the impact of protein types on texturization has been reported in studies on texture characteristics of rice and isolated soybean protein mixture (Han et al., 1989), meat substitute quality characteristics by type of isolated protein, such as soybean protein, wheat protein, mung bean protein, pea protein, and rice protein (Cho and Ryu, 2022), and quality characteristics of rice wine cake with different types of soybean protein, such as soy flour, 7S protein, and 11S protein (Hong et al., 2007). Kim et al. (2023) reported on the physicochemical characteristics depending on the mix ratio of soy and peanut proteins. Various studies have analyzed the impact of fiber mixed as additives, such as soy pulp (Cheong, 2018), mushrooms (Cho and Ryu, 2020), and yeast (Jeon et al., 2022), on the quality characteristics of extruded meat substitutes.

Previous studies have compared the effects of various types of proteins and additives on the quality characteristics of extrudates and foods. However, research is scarce on the use of rice flour as a starch source in the extrusion molding process. Therefore, this study used rice as a raw material for TVP, considering the high starch content of rice and the need to expand the use of rice. In addition, this study aimed to provide information on the effects of flour and starch from white and glutinous rice on the texturization properties of TVP made with defatted soy flour.

2. Materials and methods

2.1. Materials

The defatted soy flour used in this experiment was produced from Daewon soybeans, *Glycine max* (L.) Merrill, the most widely cultivated variety in South Korea, acquired from the National Seed Agency. The beans were dehulled, old-pressed at 80℃ to remove their oil content, and grounded into fine powder. The white rice and glutinous rice varieties were Samkwang and Dongjinchal, respectively, both harvested in 2022 in Iksan, Jeonbuk. The white rice and glutinous rice flour samples were made using an ultrafine grinder (DSCH-550-S, DUKSAN, Siheung, Korea), while the starch was extracted through an alkaline soaking method. Ingredients, such as gluten (Comida, ADM BAZANCOURT, Bazancourt, France) and corn starch (Samyang Ltd., Ulsan, Korea), were sourced from the local market.

2.2. Extrusion process

TVP was manufactured as shown in Fig. 1. The base raw material mixture for manufacturing extruded products formulation consisted of 35% defatted soybean protein, 15% isolated soybean protein, 30% gluten, and 20% corn starch, rice flour and rice starch. We used an intermeshing twin-screw extruder (Process-11, Thermo Fisher Scientific, Inc., Dreieich, Germany), outfitted with a cooling die at the end of the barrel. The extrusion parameters were established at a barrel temperature of 190℃ and a screw rotation speed of 250 rpm. Moisture was administered at an injection rate of 9 rpm using a measuring pump (BT101S Peristaltic Pump Drive, Lead Fluid Technology Co., Baoding, China), and the raw material feed rate was consistently maintained at 5 g/min.

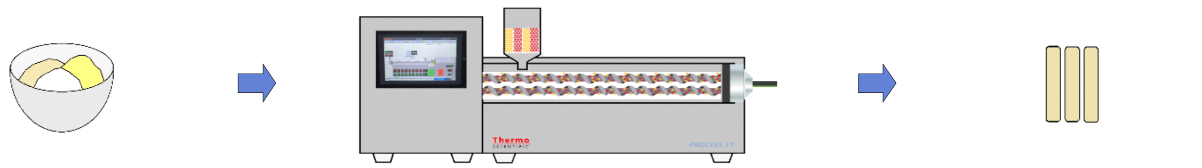

Fig. 1. Schematic of the manufacturing process of texturized vegetable protein.

2.3. Texture analysis

The textural properties, including hardness, springiness, chewiness, cohesiveness, and gumminess, were assessed using a TAXTplus texture analyzer (Zwick Roell, Ulm, Germany), with the samples cut into 1.0×1.0 cm^2 pieces and subjected to two compression cycles on a load cell (diameter: 2.5 cm) under a shear force of 30%. The cutting strength was assessed on the transverse section of the samples, cut into 1.0×2.0×0.5 cm^3 pieces, using a rheometer (SUN RHEO METER, COMPAC-100II, Sun Sci. Co., Tokyo, Japan). Moreover, the cross-section of the TVP was observed using a stereo microscope (Nicon SMZ1270, Tokyo, Japan) at a standard compound magnification of 1×1, focusing on the textural characteristics of the central cross-section.

2.4. Moisture content measurement

Moisture content was determined using the drying loss method (2.1.1.1) as specified in the Food Code. Each sample was made of 3 g of the prepared TVP, finely chopped and evenly distributed on an aluminum dish, and dried at 105°C, with its weight continuously monitored until a constant weight was achieved. The final moisture content was calculated and expressed as a percentage (%).

$$\text{Moisture content (\%)} = \frac{b - c}{b - a} \times 100 \qquad (1)$$

where a is the weight of the weighing dish (g), b is the weight of the weighing dish and sample (g), and c is the weight after drying to a constant weight (g).

2.5. Water absorption capacity measurement

Water absorption capacity was measured by cutting 10 g of the prepared TVP sample, heating it for 3 min in boiling water five times its weight, draining it through a sieve, and cooling it at room temperature for 2 h. The surface moisture of the sample was removed, and its weight was measured. The water absorption capacity was calculated using the following equation (Kang et al., 2012):

$$\text{Water absorption capacity (\%)} = \frac{\text{Post-absorption sample weight (g)} - \text{Baseline sample weight (g)}}{\text{Baseline sample weight (g)}} \times 100 \qquad (2)$$

2.6. Turbidity measurement

For turbidity measurement, the absorbance at 600 nm was measured, using a spectrophotometer (Cary 3500 Multicell Agilent, Santa Clara, CA, USA), on the liquid collected after heating 10 g of the sample for 3 min in boiling water five times its weight.

2.7. Color measurement

Each extruded TVP sample was placed on a 35-mm container, and its surface color was measured using a colorimeter (Color i7, X-rite Inc., Grand Rapids, MI, USA). The standard white plate used for measuring the TVP color had the following reference values: lightness (L*) of 95.78, redness (a*) of -0.22, and yellowness (b*) of 2.75.

2.8. Statistical analysis

The statistical analysis of the obtained results was conducted using SPSS (version 23.0, SPSS Inc., Chicago, IL, USA). The mean and standard deviation of each sample were calculated to assess the variation in the data. The differences between the samples were analyzed using one-way ANOVA

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to identify any significant variation. The Duncan's multiple range test was employed to determine which pairs of groups exhibited statistically significant differences ($p<0.05$).

3. Results and discussion

3.1. Appearance

Fig. 2 shows a visual comparison of different extruded TVP types made from white and glutinous rice. Kyriakorpoulou et al. (2021) observed that high-moisture extrusion results in the formation of a fibrous or layered structure as the material exits the cooling die. In the photos of freshly extruded TVP samples (A), a distinct layered structure, indicative of the degree of texturization, was observed in the TVP samples made from corn starch, white rice flour, and white rice starch. Among these, the white rice flour TVP exhibited the most pronounced layering. In contrast, the treatments with glutinous rice flour and starch showed less distinct layering. In the images of rehydrated TVP samples (B), produced by soaking the fresh samples (A) in water, the layers became more visibly delineated, evidenced by cracked lines on the cross-sections. This layering was most prominent in the white rice flour treatment, followed by white rice starch and corn starch. Conversely, the glutinous rice flour and starch treatments displayed minimal layered structure.

The apparent layered structure of TVPs was difficult to confirm in the glutinous rice flour and starch due to the strong cohesiveness, which is a characteristic of glutinous

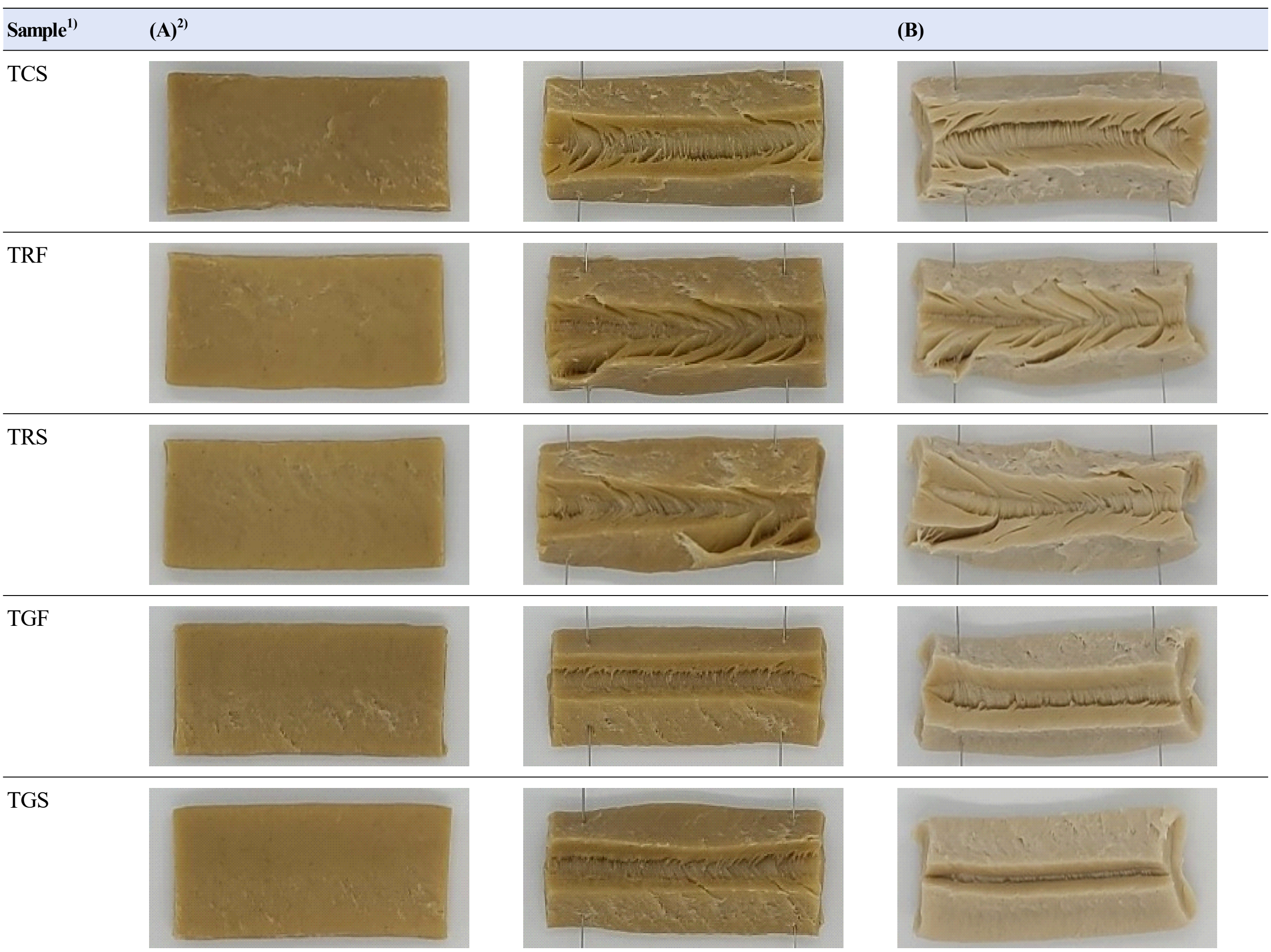

Fig. 2. Appearance of TVP using defatted soybean flour with rice flour and rice starch. [1)]TCS, texturized vegetable protein (TVP) using corn starch; TRF, tvp using rice flour; TRS, TVP using rice starch; TGF, TVP using glutinous rice flour; TGS, TVP using glutinous rice starch. [2)](A) Photograph of TVP, (B) Photograph after rehydration of dried TVP.

rice. However, in a study by Chen et al. (2022) on high-moisture extrusion structures, starch with a high ratio of amylopectin, such as waxy corn starch, is advantageous for creating protein fiber structures, and amylose is helpful for protein aggregation and formation of dense and hard structures. The results were different from those that were said to be advantageous. Thus, the interaction between amylose/amylopectin and proteins must be confirmed through SEM measurement in the future to check the formation of the internal fibrous structure.

3.2. Texturization properties

Table 1 presents the results of the texture analysis of extruded TVP made with white rice and glutinous rice. The hardness of white rice flour and starch was measured at 2,395.42 g and 2,077.08 g, respectively, indicating that the flour was 115% harder than the starch. For glutinous rice, the hardness values were 2,069.17 g for flour and 1,680.83 g for starch, with the flour exhibiting 123% hardness compared to the starch. These results demonstrate that for both white rice and glutinous rice TVP samples, flour presented higher hardness than starch. In a comparative analysis, white rice flour and starch exhibited 116% and 124% of the hardness of their glutinous counterparts, respectively. In contrast, glutinous rice starch showed 86% and 92% of the hardness of white rice flour and starch, respectively. Notably, white rice flour exhibited significantly greater hardness compared to the control (corn starch), whereas glutinous rice flour, glutinous rice starch, and white rice starch showed significantly lower hardness values ($p<0.05$). Consequently, the hardness of extruded TVP made with white and glutinous rice was higher in decreasing order of white rice flour, white rice starch, glutinous rice flour, and glutinous rice starch. Overall, rice flour demonstrated greater hardness than the control, corn starch. These results show that corn starch has a lower protein content than rice flour and higher amylopectin content, so it gelatinizes better during the extrusion molding process than rice flour, resulting in lower hardness than rice. The ratio of amylose and amylopectin is known to have an impact on the hardness of white and glutinous rice (Webb et al., 2023).

In terms of springiness, white rice flour and starch exhibited values of 0.67 and 0.68, respectively, and those of glutinous rice were 0.70 and 0.69, respectively. These findings indicate no significant difference in springiness between flour and starch within both rice types. However, glutinous rice flour exhibited significantly higher springiness compared to white rice flour, while there was no notable difference in the springiness of starch between the two rice types. Consequently, the springiness of extruded TVP made with white rice and glutinous rice was higher in decreasing order of glutinous rice flour, glutinous rice starch, white rice starch, and white rice flour. In summary, rice flour, excluding glutinous rice flour, displayed significantly higher springiness than the control, corn starch.

Gumminess was significantly higher in flour than in starch for both white rice and glutinous rice, with values of 15.04 vs. 12.49 N and 15.15 vs. 11.76 N, respectively, with no significant differences between the two rice types. Overall, all white rice and glutinous rice samples displayed significantly higher gumminess values compared to the control samples made with corn starch.

Chewiness was significantly higher in flour than in starch for both white rice and glutinous rice, with values of 10.10 vs. 8.45 and 10.56 vs. 8.13, respectively, with no significant differences between the two rice types. The control group, corn starch, displayed lower chewiness values compared to

Table 1. Texture profile analysis and cutting strength of TVP using defatted soybean flour with rice flour and rice starch

Sample[1)]	Hardness (g)	Springiness	Gumminess (N)	Chewiness	Cohesiveness (N)	Cutting strength (g/cm^2)
TCS	2,253.75±252.14[b2)]	0.71±0.02[a]	13.62±1.86[b]	9.66±1.40[b]	0.62±0.04[d]	1,253.83±107.42[c]
TRF	2,395.42±186.31[a]	0.67±0.03[d]	15.04±1.53[a]	10.10±1.17[ab]	0.64±0.04[c]	1,461.00±114.87[a]
TRS	2,077.08±187.54[c]	0.68±0.03[cd]	12.49±1.26[c]	8.45±1.06[c]	0.62±0.05[d]	1,331.00±46.18[b]
TGF	2,069.17±81.34[c]	0.70±0.03[ab]	15.15±0.85[a]	10.56±0.81[a]	0.75±0.03[a]	1,324.33±43.22[b]
TGS	1,680.83±135.61[d]	0.69±0.03[bc]	11.76±1.36[c]	8.13±1.12[c]	0.71±0.04[b]	1,244.50±31.94[c]

[1)]TCS, TVP using corn starch; TRF, TVP using rice flour; TRS, TVP using rice starch; TGF, TVP using glutinous rice flour; TGS, TVP using glutinous rice starch.
[2)]Mean±SD (n=24) within each column followed by different superscript letters are significantly different ($p<0.05$).

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the flours of white rice and glutinous rice but significantly higher values compared to their starches.

Cohesiveness was significantly higher in flour than in starch for both white rice and glutinous rice, with values of 0.64 vs. 0.62 N and 0.75 vs. 0.71 N, respectively, with glutinous rice demonstrating significantly higher cohesiveness than white rice. Moreover, all treatment samples, excluding white rice starch, displayed significantly higher cohesiveness than the control samples (corn starch).

Cutting strength was significantly higher in flour than in starch for both white rice and glutinous rice, with values of 1,461.1 vs. 1,331.00 g/cm^2 and 1,324.32 vs. 1,244.50 g/cm^2, respectively, with white rice demonstrating significantly higher values compared to glutinous rice.

These results are consistent with the finding that hardness in extrudates increases with higher rice flour content in mixtures of rice flour and isolated soybean protein (Han et al., 1989) and that hardness increases with the increase in amylose content (Bhattacharya et al., 1986; Kim et al., 2020). However, they did not align with the findings of the study by Chen et al. (2021) that hardness, springiness, and chewiness of plant protein extrudates were significantly reduced by the addition of amylose and amylopectin.

In summary, hardness and cutting strength were higher in white rice compared to glutinous rice, and higher in flour than in starch. Conversely, glutinous rice demonstrated greater springiness than white rice, with flour outperforming starch. Regarding gumminess and chewiness, no significant differences were noted between the two types of rice, but flour consistently showed superior performance over starch. In this study, rice flour and rice starch significantly differed in terms of hardness, gumminess, and chewiness. In other words, rice starch has a lower protein content and a higher amylopectin content than rice flour. Thus, rice starch was easily gelatinized and had a soft and somewhat viscous texture during the TVP manufacturing process. On the other hand, TVP made from rice flour had a 15% harder consistency than rice starch. These findings support the feasibility of using rice flour in the production of TVP, confirming it as an effective alternative to traditional starch sources. Additionally, this approach offers the benefit of streamlining the production process by obviating the need for starch extraction.

3.3. Color

Table 2 presents the results of the colorimetric analysis for extruded TVP made with white rice and glutinous rice. The lightness value (L*) was the highest for the control group (i.e., corn starch) at 56.77. Both white rice and glutinous rice showed lower L* values in flour compared to starch, with white rice exhibiting higher lightness than glutinous rice. In the chromaticity measurement of rice flour by variety, Parketal (2017) found that non-glutinous rice had the highest value (L*), indicating a closer white color, while glutinous rice had the lowest value (L*). This finding is in line with the findings of the study by Lee and Yoon (2017), who reported that pumpkin porridge prepared with white rice flour appeared lighter in color compared to when prepared with glutinous rice flour, reflecting the inherently higher lightness of white rice flour. The redness value (a*) was lowest in corn starch at 5.30. In both rice types, no significant differences were observed in the redness value between flour and starch, which were 5.96 and 5.91 for white rice and 6.36 and 6.31 for glutinous rice, while glutinous rice exhibited significantly higher values compared to white rice ($p<0.05$). The yellowness value (b*) was lowest in corn starch, with both white and glutinous rice showing higher values in flour than in starch, registering 21.43 vs. 20.44 for white rice and 23.00 vs. 22.26 for glutinous rice. In both flour and starch, glutinous rice demonstrated significantly higher values. These results contrast with the findings of Kim et al. (2020), in which the higher the rice flour content, the lower the a* and b* values in puffed snacks made with corn and rice flour. Similarly, Sim et al. (2001) observed an increase in L* and b* with increasing rice flour content and corn flour content in fish snacks, respectively. These results support a positive correlation between

Table 2. Hunter's color value of TVP using soybean proteins with rice flour and rice starch

Sample[1)]	Hunter's color value		
	L*	a*	b*
TCS	56.77±1.55[a2)]	5.30±0.39[d]	19.87±0.87[d]
TRF	54.67±0.37[c]	5.96±0.10[b]	21.43±0.65[c]
TRS	55.91±0.59[b]	5.91±0.14[b]	20.44±0.49[d]
TGF	53.22±0.85[d]	6.36±0.13[a]	23.00±0.80[a]
TGS	53.76±0.49[d]	6.31±0.10[a]	22.26±0.78[b]

[1)]TCS, TVP using corn starch; TRF, TVP using rice flour; TRS, TVP using rice starch; TGF, TVP using glutinous rice flour; TGS, TVP using glutinous rice starch.
[2)]Mean±SD (n=9) within each column followed by different superscript letters are significantly different ($p<0.05$).

the lightness and moisture content of extrudates (Park et al., 2017), which explains the reduced lightness in the extrudates made with low-moisture white rice and glutinous rice.

3.4. Moisture content, water absorption capacity, and turbidity

Table 3 lists the results for moisture content, water absorption capacity, and turbidity of extruded TVP prepared with white rice and glutinous rice. The moisture content was significantly higher in starch than in flour for both types of rice, that is, for white rice was 44.17% in flour compared to 46.7% in starch, and for glutinous rice it was 43.53% in flour compared to 47.66% in starch ($p<0.05$). Comparing white rice with glutinous rice, no significant difference was observed in flour, but glutinous rice starch exhibited a significantly higher moisture content than that of white rice. This is because glutinous rice has a high amylopectin content, which easily binds with water due to its highly branched structure. The control group, corn starch, with a moisture content of 46.44%, showed a significantly higher value compared to flour and a lower value compared to the starch of both rice types. This implies that white rice starch, with its lower amorphous content and higher internal density, has a reduced water absorption capacity compared to glutinous rice starch, as suggested by Kim and Shin (1992). Furthermore, rice flour with higher cutting strength displayed lower moisture content than rice starch, aligning with Park et al.'s (2017) findings that increased moisture content reduces the cutting strength of extrudates. The water absorption capacity was 4.83% in white rice flour and 4.81% in starch, while for glutinous rice, it was 7.40% in flour and 7.60% in starch. Glutinous rice with a high amylopectin content easily combined with gelatinized water, showing slightly higher water absorption capacity than non-glutinous rice, but the difference is insignificant. Thus, the water absorption capacity is influenced by the structural characteristics of starch, the raw material of TVP. In the study of Hong et al. (2023), protein type, protein-water molecule interaction, water-water molecule interaction and product structure were reported to be more closely related to porosity and bubble size. Point towards water absorption capacity as a TVP quality index and, meanwhile the porosity of the low-moisture meat analogues is known to affect water absorption capacity due to the diffusion of water molecules (Lee et al., 2022). Turbidity was significantly lower in white rice flour (0.168%) than in starch (0.216%), while lower in glutinous rice starch (0.173%) than in flour (0.194%). In direct comparisons, white rice flour had lower turbidity than glutinous rice flour, and glutinous rice starch showed lower turbidity than white rice starch. The control group, corn starch, demonstrated the highest turbidity at 0.252. In a study that examined the effects of defatting temperature, ranging from 70 to 100℃, on the textural quality and turbidity of extruded defatted soy flour, Park et al. (2023) reported that samples extruded at 100℃ exhibited lower textural quality and increased turbidity. This finding suggests that the denser and more solid structure of extruded white rice flour may be a contributing factor to its lower turbidity. Overall, the use of rice flour for TVP shows positive effects on appearance and texture as well as water absorption capacity and turbidity related to rehydration. It will be possible to replace starch raw materials in terms of simplifying the processing step and promoting rice consumption.

Table 3. Moisture content, water absorption capacity and turbidity of TVP using soybean proteins with rice flour and rice starch

Sample[1)]	Moisture content (%)	Water absorption capacity (%)	Turbidity (%)
TCS	46.44±0.43$^{b2)}$	7.06±2.78^{a}	0.252±0.008^{a}
TRF	44.17±0.33^{c}	4.83±0.56^{a}	0.168±0.011^{d}
TRS	46.71±0.24^{b}	4.81±1.75^{a}	0.216±0.006^{b}
TGF	43.53±0.50^{c}	7.40±1.66^{a}	0.194±0.011^{c}
TGS	47.66±0.74^{a}	7.60±0.58^{a}	0.173±0.007^{d}

[1)] TCS, TVP using corn starch; TRF, TVP using rice flour; TRS, TVP using rice starch; TGF, TVP using glutinous rice flour; TGS, TVP using glutinous rice starch.
[2)] Mean±SD (n=3) within each column followed by different superscript letters are significantly different ($p<0.05$).

4. Conclusions

This study analyzed the quality of TVP made from defatted soy flour combined with flour or starch from rice sources. The base raw material formulation consisted of 50% soybean protein, 30% gluten, and 20% rice flour and rice starch. A cooling die-equipped extruder was used with a barrel temperature of 190℃ and screw rotation speed of 250 rpm. The hardness and cutting strength of the extruded TVP were found to be higher for white rice than for glutinous rice and higher for flour than for starch. Gumminess and chewiness were similar across rice types, but higher for flour

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than for starch. White rice TVP had lower water absorption capacity than glutinous rice TVP. Turbidity was lowest for white rice flour and highest for corn starch. From the above results, it was confirmed that white rice flour showed a superior texture compared to corn starch and rice starch. Accordingly, rice flour can be used as a starch source for the production of TVP.

The use of rice flour eliminates the starch separation process, simplifying the manufacturing steps. In terms of nutrition, the methionine component, which is lacking in soy protein, can be supplemented when mixed with rice flour, making it nutritionally superior. This could also contribute to promoting rice consumption.

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Conflict of interests

The authors declare no potential conflicts of interest.

Author contributions

Conceptualization: Park CS, Kim YS. Methodology: Park CS. Formal analysis: Park CS, Seo MS, Jung SY, Lee S. Validation: Park CS, Seo MS, Park B, Park SY. Writing - original draft: Park CS. Writing - review & editing: Park CS, Seo MS.

Ethics approval

This article does not require IRB/IACUC approval because there are no human and animal participants.

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