Enrichment of Rice with Grape Peel Powder by Extrusion

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***Abstract*—Following the tendency to reduce food loss and contributing with environment sustainability, generating value-added utilizing food industry residues, this research aims thetechnological characterization of grape by-productand rice extruded flour. The physical behavior of rice (*Oryza sativa* L.) and grape peel (*Vitis vinifera* L.) extruded flours were investigated. A range of grape peel (15 - 25%, screw speed (100 - 150 rpm) and moisture content (18 - 26%) were studied. The aim of this study was to evaluate the effect of extrusion cooking process in a grape peel powder and the white rice flour addition. The results of bulk density was between 270 and 566 kg/m^3; sectional expansion ratio was 2.42 to 6.51; longitudinal expansion ration was 0.58 to 0.96; volumetric expansion ratio was 2.15 to 4.64; water solubility index was 7.60 to 15.57; water absorption index was 4.35 to 6.82. Results of instrumental color was measured and the range of L* was 26.38 to 37.68; a* was 11.70 to 14.56 and b* was 3.78 to 7.42. The grape peel addiction on extrudates increased the bulk density and longitudinal expansion index. However, decreased on sectional expansion index, volumetric expansion index, water solubility index, water absorption index and luminosity. Results obtained with conditions processing demonstrated the incorporation of grape peel in rice is viable.**

***Index Terms*—extruded, by-product, characterization**

I. Introduction

The primary sourceof human foods consumed in many countries are cereal and their derivates. Rice (*Oryza sativa* L.) is one of the global staple foods most important for more than two-thirds world population with a huge cultivation worldwide [1]-[3]. Therefore, rice is used in many gluten free products and has a large acceptability and aneutral taste and color [4], [5].

Grapes (*Vitis spp*.) are one of the most consumed fruit in the world. The winemaking industry generates a lot of waste like peels, seeds and stems. This waste is considerate grape pomace and has an economic and environment impact [6]. It has many bioactive compounds and can be used as a by-product, with added-value products [7].

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Mixtures of ingredients are advantageous and each ingredient can contribute to improve the dough or the final product, making the product appealing [4].

There is a tendency to reduce food loss and waste with environmental sustainability, one way is enrichment food using agro-industrial by-product. It's possible to use pomace and others by-products to enhance nutritional quality, being a good source of fibers, micronutrients and others bioactive compounds [4], [5].

Extrusion cooking process is a high-temperature short time (HTST) technology, using mechanic forces and pressure, changing the molecular structure of the starch and protein [7]. This technology is also used to improve food by-products [8] and develop dietary fiber enriched foods [9].

After the extrusion cooking, the extrudates digestibility is increased and this could be explained by the own process [10]. The extrusion cooking process may gelatinize and disintegrate the starch, being more accessible to amylolytic hydrolysis and then, rising the starch digestibility [11].

Extrusion cooking was chosen a favorite technology over the conventional techniques because is possible to promote versatile products with different textural properties, like expansion, crispiness and mouthfeel. The technology has high productivity, a short period of cooking process and low costs with operation and energy. In addition, makes better the nutrients bioavailability and digestibility [12].

Many studies of fruit by-products were done to create new possibilities using extrusion cooking. Matejová, Fikselova [5] added grape pomace in gluten free biscuits. Alves, Berrios [13] extruded passion fruit shell and rice flour. Extruded rice flour and apple pomace [14]. Cereal breakfast extrudates with rice and pomelo rind [15]. Sugar replacement using citrus fiber extracted from orange pulp on wheat-corn extrudates [16]. Cherry pomace and direct expanded corn starch [17]. Oladiran and Emmambux [18] studied the nutritional and functional properties of extruded cassava-soy composite with grape pomace and concluded that it is possible to develop instant products with health promoting properties, based in starch-rich foods added with grape pomace, using extrusion cooking process.

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Follow the tendency of heathier products and sustainable development and also a gluten-free food, the combination of rice and grape peel using extrusion cooking process is a good alternative to formulate new products based in these extrudates flours. The aim of this work was the development of mixed flours of rice and grape peel by extrusion cooking and the usefulness to future possibilities.

II. Material and Methods

A. Raw Material

White rice (*Oryza sativa* L.) was purchased in local shops (Rio de Janeiro, Brazil). Grape pomace (Alicante Bouschet) from the production of grape wine was donated by Embrapa (Petrolina - PE/Brazil) and was manually separated and the peels were used in this study. Rice and grape peel were ground, separately, in a Laboratory Mill 3600 disk mill (Perten Instruments, model 2600, KungensKurva, Sweden).

B. Sample Preparation

The moisture content of the raw materials was calculatedand was added waterto equalize the moisture, according to the experimental design, shown in Table I. The blends were stored under refrigeration conditions to balance the moisture, overnight.

C. Extrusion Cooking Process

The process was in a single-screw extruder Brabender 20DN DSE. A feed rate of 3.0 kg/h and the zones of temperature were 60 ℃, 80 ℃ and 150 ℃ were constant throughout the process at a pressure of 9-11 MPa. The screw configuration was L/D 1:3 (compression ratio) and included a circular die 3 mm diameter. The screw speed, moisture and percentage of grape peel were not constant and could be verified with the experimental design in the Table 1. After extrusion cooking, the extrudates were dried in a forced-air drier (WTB Binder, Tuttlinger, Germany) at 60 ℃ for 4 h up to obtain the range of 4 - 7g/100g moisture. The extrudates were milled in a disc mill. The extruded flours were maintained under refrigeration (5 - 8 ℃) until further analysis.

D. Experimental Design

The experiments were conducted using factorial design 2^3 with four central points. Dependents variables were: X_1 screw speed (SS, rpm), X_2 feed moisture (FM, %) and X_3 grape peel proportion (GS, %) and the code levels studied are present in Table I.

TABLE I. Code Levels to Independent Variables

Variable	Code level		
	-1	0	+1
Screw speed (SS, rpm)	100	125	150
Feed moisture (FM, %)	18	22	26
Grape peel(GS,%)	15	20	25

E. Bulk Density

Bulk density is measurement of mass and volume. The diameter was measured with a digital caliper (Vonder, Curitiba, Brazil) and the length per unit weight (g) of the extrudates was determined. Density was calculated by the Equation (4). The methodology was described by Alvarez-Martinez, Kondury [19].

$$Density\ (\rho_e) = \frac{4m}{\pi D^2 L} \tag{1}$$

F. Expansion Ratio

To determine the expansion ratio mean a digital caliper was used on 15 samples. Expansion indices: sectional (SEI), longitudinal (LEI) and volumetric (VEI) was calculated by measuring, according with the Equations (2), (3) and (4), respectively.

$$SEI = \left[\!\left[\frac{D}{D_0}\right]\!\right]^2 \tag{2}$$

$$LEI = \left[\!\left[\frac{\rho_d}{\rho_e}\right]\!\right] \left[\!\left[\frac{1}{SEI}\right]\!\right] \left[\!\left[\frac{1-M_d}{1-M_e}\right]\!\right] \tag{3}$$

$$VEI = SEI\ x\ LEI \tag{4}$$

where D is the extrudate diameter and D_0 is the diameter of the die. ρ_d was defined to be 1400 g.cm^{-3}, the bulk density of the melt. ρ_e is the extrudates density. M_e is the extrudate moisture content and M_d is the melt moisture content. The triplicate measurement was done with 2 g samples in an oven drier at 105 ℃ for 2 hours.

G. Water Absorption and Water Solubility Indexes

The WSI and WAI of the samples were determined in quadruplicate as described by [20]. WSI is the sample mass in supernadant divided by sample mass. Moreover, WAI is the sample mass with absorbed water divided by sample mass. The results were obtained by the Equations (5) and (6).

$$WAI = \frac{g\ water\ absorved}{g\ dry\ sample\ x\ [\![1-(soluble\ fraction)]\!]} \tag{5}$$

$$WSI = \frac{g\ water\ soluble\ matter}{g\ dry\ sample} \tag{6}$$

H. Instrumental Color

A colorimeter CR 400 (Konica Minolta, Osaka, Japan) was used to measure the color of the extruded flours and grape peel powder. The measurements were done in three replications in the CIE-Lab parameters as L* (whiteness/darkness), a* (redness/greenness) and b* (yellowness/blueness).

I. Statistical Analysis

Linear model was used and includes means effects and interactions (Eq. 7) to present the values of response based on independent variables function studied.

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1(SS) + \hat{\beta}_2(FM) + \hat{\beta}_3(GS) + \hat{\beta}_{12}(SS \times FM) + \hat{\beta}_{13}(SS \times GP) + \hat{\beta}_{23}(FM \times GS) \tag{7}$$

where $\hat{Y}$: predict response; SS: main effect of screw speed (rpm); FM: main effect of feed moisture (%); GS: main effect of grape peel (%); SS X FM, SS X GS and FM X GS: interactions effects; $\widehat{\beta}_0$: regression coefficient mean.

Analysis of variance (ANOVA) test was carried out using the Statistic v.12.0 software with 5% of significance.

III. Results and Discussion

The data with regard to rice extrudates with distinct parameters: screw speed, feed moisture and grape peel flour content. For the characterization purpose, bulk density, expansion ratio, WSI, WAI and color analysis were done and responsesand real levels werepresented in the Table II.

Bulk density is related with mass and volume, being inversely proportional to volume expansion index. In the experiment, run 7 and run 2 hadthe higher and the lower values, suggesting that increasing feed moisture and grape peel content, resulted bulk density increased. Bulk density, feed moisture and grape peel interactions are shown on the Fig. 1.

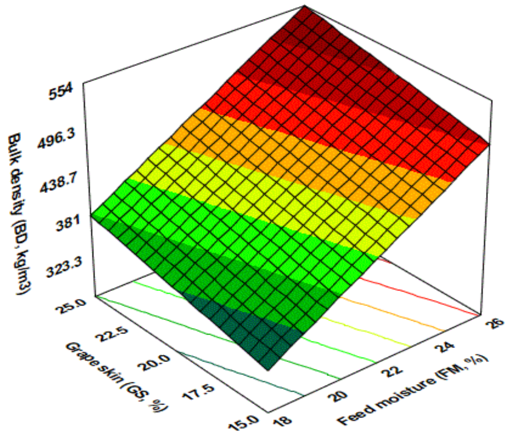

Figure 1. Interaction between bulk density, feed moisture and grape peel on extrudates.

TABLE II. REAL LEVELS OF EXTRUSION PARAMETERS AND RESPONSES OF RICE AND GRAPE PEEL EXTRUDATES

Run	Real levels			Responses								
	SS rpm	FM %	GS %	BD	SEI	LEI	VEI	WSI	WAI	L*	A	b
1	100	18	15	373.0±12.0	5.05±0.18	0.67±0.00	3.40±0.11	11.22±0.23	4.55±0.02	34.71±0.19	13.16±0.08	5.65±0.02
2	150	18	15	270.6±10.4	6.51±0.30	0.72±0.01	4.64±0.18	15.53±0.31	5.09±0.02	37.68±0.30	14.56±0.03	7.42±0.02
3	100	26	15	444.5±91.8	4.78±0.96	0.58±0.03	2.77±0.56	13.5±0.25	6.06±0.01	28.96±0.11	12.04±0.81	4.29±0.47
4	150	26	15	513.4±15.6	3.72±0.09	0.64±0.01	2.39±0.07	15.57±0.14	6.82±0.05	27.29±0.65	13.64±0.45	5.16±0.36
5	100	18	25	370.0±10.0	4.68±0.14	0.72±0.01	3.41±0.09	11.57±0.45	4.35±0.04	31.57±0.41	13.71±0.17	5.57±0.05
6	150	18	25	352.1±32.4	4.59±0.19	0.83±0.04	3.73±0.32	12.43±0.09	4.56±0.09	31.04±0.03	14.03±0.08	5.81±0.00
7	100	26	25	566.5±17.9	3.46±0.17	0.62±0.01	2.15±0.08	7.60±0.04	5.64±0.00	26.38±0.46	12.41±0.09	4.14±0.23
8	150	26	25	538.5±9.4	2.42±0.04	0.96±0.01	2.34±0.04	9.04±0.05	4.91±0.01	28.46±0.79	11.70±0.46	3.78±0.21
9	125	22	20	455.1±7.0	4.15±0.07	0.65±0.01	2.72±0.04	10.71±0.01	4.84±0.00	29.73±0.62	12.40±0.07	5.77±0.10
10	125	22	20	494.7±53.0	3.86±0.40	0.70±0.01	2.46±0.25	8.88±0.10	4.79±0.01	29.79±0.18	12.30±0.01	5.41±0.10
11	125	22	20	447.6±23.2	4.06±0.25	0.69±0.02	2.79±0.14	9.22±0.02	4.82±0.00	27.92±0.34	12.89±0.09	5.68±0.02
12	125	22	20	437.9±19.4	4.29±0.20	0.70±0.01	2.84±0.12	9.96±0.10	5.13±0.08	29.24±0.34	12.68±0.35	5.81±0.36

SS: Screw speed; FM: Feeoisture; GS: Grape peel; BD: Bulk density (Kg/m^3); SEI: Sectional expansion index; LEI: Longitudinal expansion index; VEI: volumetric expansion index; WSI: Water solubility index; WAI: water absorption index. Results are mean standard deviation, n= 15 observations.

Others extrudates studies with carrot pomace and corn ([21], passion fruit shell with rice [13], citrus fiber with wheat-corn [16] described similar results.

Moisture loss is the comparison between the final product and the mixture before extrusion. Increasing the addition of grape peel flour, the moisture content increased. Probably, the higher amount of dietary fiber presents on grape peel flour absorbed and confined more moisture than white rice extrudates. Shi *et al*. (2017) reported similar result with brown rice and pomelo rind.

Expansion ratio analysis can be correlated with others analysis to have a product overview characteristics. The samples had a lower expansion ratio in comparison with rice samples, without grape peel addition.

Others studies had the same conclusion, demonstrating association among extrudates and fibers quantity. The products had water retention and the expansion ratio was reduced with increased in density product [15].

Sectional expansion index (SEI) is the ratio between cross-sectional area of the extrudates and the cross-sectional area of the die. Both feed moisture and grape peel affected the SEI at all extrusion conditions. The influence of feed moisture and grape peel on sectional expansion index is shown in Fig. 2.

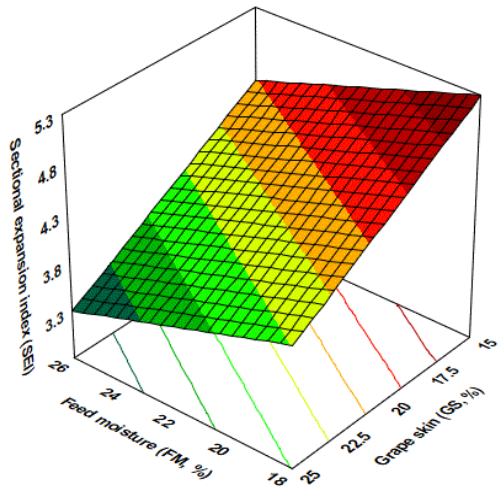

Figure 2. Interaction between sectional expansion index, feed moisture and grape peel.

In the current study, the higher SEI was negative interaction with feed moisture and grape peel. Thus, with the addition of grape peel and the increase the feed moisture made the sectional expansion index decreased. Mainly, extruded blends of pea protein, pea fiber and rice starch had reduced the SEI with the increase of moisture content [22].

The effect of screw speed and grape peel on longitudinal expansion index was presented in Fig. 3.

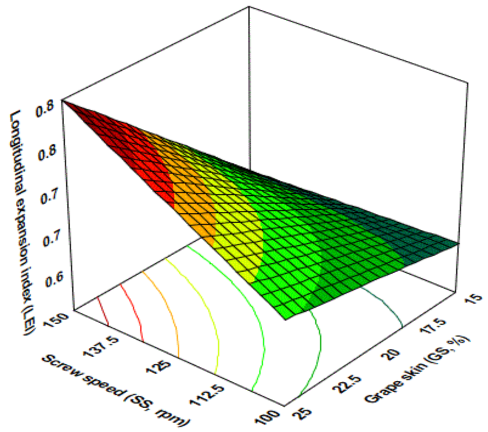

Figure 3. Interaction between longitudinal expansion index, feed moisture and grape peel.

Higher values of grape peel and screw speed create higher values on LEI. This effect may be due to a reduction in viscosity and starch with less damage. Thus, the dough possibly expanded more and faster. Similar studies were reported by Ačkaret al. (2018), Beck et al. (2018) and Basediya *et al*. (2013).

It is believed that the addition of materials with high fiber content, such as grape peel, has a negative influence on the expansion. Whereas during the melting of the ingredients, the amylaceous structures contained do not achieve sufficient elution bonds between the amylose/amylopectin chains. Making the final product have a lower degree of expansion. Although this is a finding, the product according to the added percentile allows the fusion between the rice and the grape peel. In this way, it becomes feasible its use in the preparation of other foods.

The influence of feed moisture and grape peel on volumetric expansion index was presented in Fig. 4.

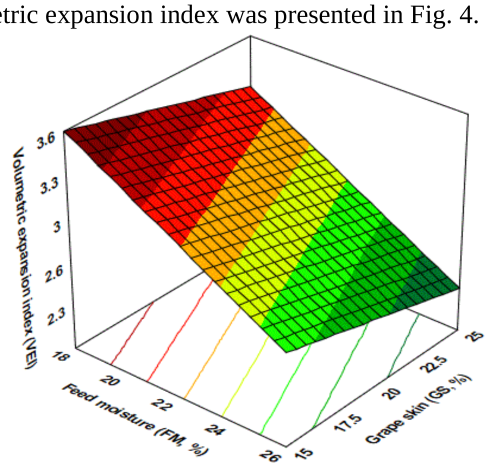

Figure 4. Interaction between volumetric expansion index, feed moisture and grape peel.

Increasing feed moisture and grape peel content generates extrudates with low VEI values.

Feed moisture has been found to be the essential factor affecting bulk density and expansion [14], [22]which is agreement with our findings. There is a huge relation between bulk density and expansion on the feed moisture of starch based materials, which indicates the importance on elasticity characteristics of extrudates. During extrusion, increasing feed moisture amylopectin molecular structure changes, reducing the melt elasticity, decreasing the expansion and increasing the density of extrudates. Ačkar, Jozinović [23] studied and solved the problem of poor expansion in corn extrudates enriched with brewer's spent grain, sugar beet pulp and apple pomace adding pectin.

Usually, the WAI and WSI indexes show the hydrophobic and hydrophilic characterizations of the samples that could be the affected by degree of starch degradation, hydration of fiber, protein denaturation [24].

The effect of screw speed and grape peel on water solubility index was presented in Fig. 5.

Increasing the screw speed the WSI was increased. The grape peel demonstrated negative effect on extruded flour, due to improve the starch-interaction and consequently, reducing the solubility.Others researches reported similar conclusions [13].

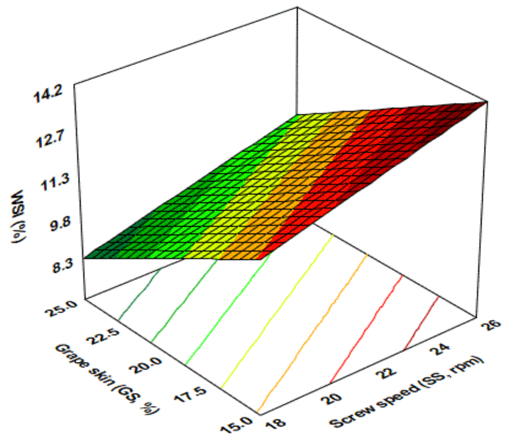

Figure 5. Interaction between water solubility index, grape peel and screw speed.

Low screw speed collaborates to reducing WSI values. High screw speed break up the long into shorter starch chain and this structure is more soluble than long chain, increasing the degradation ratio of starch granules.

The WSI analysis with extruded rice had enhanced from 9.16 to 50.13 $g.g^{-1}$. These results were caused by thermal and mechanical effect [25]. However, in a study with rice and oat extrudates have a reduction of WSI. It could be explain by the lipophilic characteristic of the mixture, protecting the starch granules in high screw speed [26].

The influence of screw speed and grape peel on water absorption index was presented in Fig. 6.

Considering the statistical analysis obtained and using the principle of hierarchy the SS effect was removed, as a result of the effect of screw speed x feed moisture interaction was significant.

According to the study of the effect of extrusion temperature and screw speed on properties of oat and rice flour extrudates by [26], the WAI have a significant positive linear effect by screw speed.

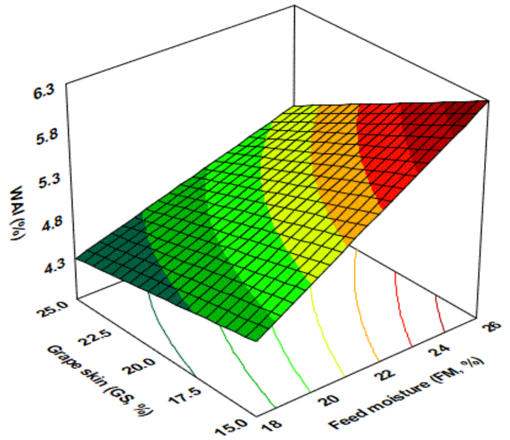

Figure 6. Interaction between water absorption index, grape peel and screw speed.

Color is an important product parameter for consumers. The extrudates were milled and the flours were analyzed. Higher values luminosity (L*) was observed in run 2, which has lower grape peel. Similarly, the higher grape peel content has the lower luminosity value.

The grape peel flour was the darker and the control was the lighter by the absence of grape peel. Thus, increasing grape peel content, the extrudates color became darker, indicating that the grape peel had a strong effect on the color of the extrudates flours. Oppositely, redness (a*) samples were similar to each other. No trend was observed in yellowness (b*).

In view of the expose the use of by-products is rising with added-value new products and increasing the amount of bioactive compounds in extrudates [12].

IV. Conclusions

Extrusion cooking plays an important role as alternative to the developing by-products.Results obtained with conditions processing demonstrated the incorporation of grape peel in rice is viable. However, is necessary to do some adjusts in parameters of processing to purpose to obtain products with technologic characteristics to be attractive to the consumers. For future studies, new products using this extruded flour with nutritional analysis and sensory evaluation are the goal.

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References

[1] E. Xu, *et al*., "Response surface methodology for evaluation and optimization of process parameter and antioxidant capacity of rice flour modified by enzymatic extrusion," *Food Chemistry*, vol. 212, pp. 146-154, 2016.

[2] E. S. Gong, *et al*., "Phytochemical profiles and antioxidant activity of processed brown rice products," *Food Chemistry*, vol. 232, pp. 67-78, 2017.

[3] M. N. Ndjiondjop, *et al*., "Drought resistance in an interspecific backcross population of rice (Oryza spp.) derived from the cross WAB56-104 (O. sativa)×CG14 (O. glaberrima)," *Plant Science*, vol. 179, no. 4, pp. 364-373, 2010.

[4] M. D. Cairano, *et al*., "Focus on gluten free biscuits: ingredients and issues," *Trends in Food Science & Technology*, 2018.

[5] S. Matejová, *et al*., "Application of by-products in the development of foodstuffs for particular nutritional uses," *Journal of Central European Agriculture*, vol. 17, no. 4, pp. 1306-1319, 2016.

[6] A. R. Fontana, A. Antonioll i, and R. Bottini, "Grape pomace as a sustainable source of bioactive compounds: Extraction, characterization, and biotechnological applications of phenolics," *Journal of Agricultural and Food Chemistry*, vol. 61, no. 38, pp. 8987-9003, 2013.

[7] S. Sánchez-Tena, *et al*., "Grape antioxidant dietary fiber inhibits intestinal polyposis in Apc Min/+ mice: relation to cell cycle and immune response," *Carcinogenesis*, vol. 34, no. 8, pp. 1881-1888, 2013.

[8] L. Román, *et al*., "Changes in physicochemical properties and in vitro starch digestion of native and extruded maize flours subjected to branching enzyme and maltogenic α-amylase treatment," *International Journal of Biological Macromolecules*, vol. 101, pp. 326-333, 2017.

[9] V. Stojceska, *et al*., "The effect of extrusion cooking using different water feed rates on the quality of ready-to-eat snacks made from food by-products," *Food Chemistry*, vol. 114, no. 1, pp. 226-232, 2009.

[10] M. A. Brennan, *et al*., "Impact of guar and wheat bran on the physical and nutritional quality of extruded breakfast cereals," *Starch-Stärke*, vol. 60, no. 5, pp. 248-256, 2008.

[11] A. K. Shrestha, *et al*., "Molecular, mesoscopic and microscopic structure evolution during amylase digestion of extruded maize and high amylose maize starches," *Carbohydrate Polymers*, vol. 118, pp. 224-234, 2015.

[12] C. Brennan, *et al*., "Effects of extrusion on the polyphenols, vitamins and antioxidant activity of foods," *Trends in Food Science & Technology*, vol. 22, no. 10, pp. 570-575, 2011.

[13] P. L. D. S. Alves, *et al*., "Passion fruit shell flour and rice blends processed into fiber-rich expanded extrudates," *CyTA-Journal of Food*, vol. 16, no. 1, pp. 901-908, 2018.

[14] M. Mehraj, *et al*., "Development and ev development and evaluation of extruded product tion of extruded product of rice flour and apple pomace," *Development*, vol. 13, no. 1, pp. 21-262018.

[15] N. Shi, *et al*., "Manipulation of antioxidant and glycaemic properties of extruded rice based breakfast cereal products using pomelo fruit by-product material," *Quality Assurance and Safety of Crops & Foods*, vol. 9, no. 4, pp. 489-495, 2017.

[16] K. F. Pitts, *et al*., "Effect of the sugar replacement by citrus fibre on the physical and structural properties of wheat-corn based extrudates," *Food and Bioprocess Technology*, vol. 9, no. 11, pp. 1803-1811, 2016.

[17] S. Wang, *et al*., "Impacts of the particle sizes and levels of inclusions of cherry pomace on the physical and structural properties of direct expanded corn starch," *Food and Bioprocess Technology*, vol. 10, no. 2, pp. 394-406, 2017.

[18] D. A. Oladiran and N. M. Emmambux, "Nutritional and functional properties of extruded cassava-soy composite with grape pomace," *Starch - Stärke*, vol. 70, no. 7-8, p. 1700298, 2018.

[19] L. Alvarez-Martinez, K. P. Kondury, and J. M. Harper, "A general model for expansion of extruded products," *Journal of Food Science*, vol. 53, no. 2, pp. 609-615, 1988.

[20] R. Anderson, "Gelatinization of corn grits by roll-and extrusion-cooking," *Cereal Science Today*, vol. 14, pp. 4-12, 1969.

[21] N. Kaisangsri, *et al*., "Carrot pomace enhances the expansion and nutritional quality of corn starch extrudates," *LWT-Food Science and Technology*, vol. 68, pp. 391-399, 2016.

[22] S. M. Beck, *et al*., "Low moisture extrusion of pea protein and pea fibre fortified rice starch blends," *Journal of Food Engineering*, vol. 231, pp. 61-71, 2018.

[23] Đ. Ačkar, *et al*., "Resolving the problem of poor expansion in corn extrudates enriched with food industry by-products," *Innovative*

Food Science & Emerging Technologies, vol. 47, pp. 517-524, 2018.
[24] M. Brown, *et al*., "A comparative study of the effects of non-starch polysaccharide gums on physical properties of single-screw extruded aquafeed," *Journal of Food Processing & Technology*, vol. 6, no. 6, p. 457, 2015.
[25] A. Hagenimana, X. Ding, and T. Fang, "Evaluation of rice flour modified by extrusion cooking," *Journal of Cereal Science*, vol. 43, no. 1, pp. 38-46, 2006.
[26] R. Sandrin, *et al*., "Effect of extrusion temperature and screw speed on properties of oat and rice flour extrudates," *Journal of the Science of Food and Agriculture*, vol. 98, no. 9, pp. 3427-3436, 2018.

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