agronomy

MDPI

Communication

Quality Characteristics of Noodles Processed from Rice Grains of the Ratoon Crop

Zhengwu Xiao [1,†], Chengjing Liao [1,†], Yuping Hu [1], Keqian Zhang [1], Jiana Chen [1], Fangbo Cao [1], Shengliang Fang [2] and Min Huang [1,*]

[1] Rice and Product Ecophysiology, Key Laboratory of Ministry of Education for Crop Physiology and molecular Biology, Hunan Agricultural University, Changsha 410128, China
[2] Hengyang Academy of Agricultural Sciences, Hengyang 421101, China
* Correspondence: mhuang@hunau.edu.cn
† These authors contributed equally to this work.

Abstract: Rice noodles are usually manufactured using rice grains of the main crop. There is limited information available on rice noodles processed from ratoon rice grains. In this study, two-year field experiments were conducted to compare the cooking and texture properties of noodles and the grain chemical properties of ratoon crops with those of main crops from two rice cultivars (Guichao 2 and Zhenguiai) that are widely used for processing noodles. Results showed that the cooked break rate and the cooking loss rate of rice noodles processed from grains of the ratoon crop were similar to those of the main crop in both cultivars; however, changes in texture of cooked rice noodles processed from grains of the ratoon crop compared with the main crop were cultivar-dependent, being significantly softer in Zhenguiai but not in Guichao 2. Hardness and chewiness of cooked rice noodles were significantly negatively correlated with amylopectin content in milled rice grains in Zhenguiai, indicating that amylopectin content is a key chemical property determining the texture differences between rice noodles processed from grains of ratoon and main crops.

Keywords: cooking properties; grain chemical properties; rice ratooning; rice noodles; texture profiles

Citation: Xiao, Z.; Liao, C.; Hu, Y.; Zhang, K.; Chen, J.; Cao, F.; Fang, S.; Huang, M. Quality Characteristics of Noodles Processed from Rice Grains of the Ratoon Crop. *Agronomy* **2022**, *12*, 2739. https://doi.org/10.3390/agronomy12112739

Academic Editor: Begoña Blasco

Received: 30 September 2022
Accepted: 3 November 2022
Published: 4 November 2022

1. Introduction

Rice ratooning—an ancient labor-saving rice-cultivation practice—refers to the cultivation of a second rice crop regenerated from the stubble of the main crop after harvest [1]. Adoption of this practice is becoming more and more widespread in China with the development of multiple high-yielding and high-efficiency management strategies, including the use of high-yielding cultivars, mechanical harvesting of the main crop, and optimal water and nutrient management [2]. In addition, the development of rice ratoon crops is generally considered to improve the grain quality of rice and hence meet the substantially increased demand for high-quality rice in China due to improved economic and living standards [3].

The grain quality of rice is a composite characteristic that includes milling recovery, appearance, cooking, eating, and nutritional properties [4]. Among these properties, eating quality is considered the most important in the satisfaction of consumers [5]. Most of Chinese consumers prefer soft-texture cooked rice with low amylose content of about 15% (or 150 mg g^{-1}) or even lower [6]. Although ratoon rice crops generally have better grain quality than the main crop [3], their grain quality is highly dependent on the genotype. There is still a certain number of high-amylose cultivars in rice production of China, and the eating quality of ratoon rice from such cultivars cannot meet the consumer preference for cooked rice with soft texture. However, high-amylose cultivars are important in terms of rice products. In particular, rice grains with high amylose content (>22% or 220 mg g^{-1}) are suitable for processing rice noodles [7], which are a traditional and popular staple food item in Southern China [8].

Rice noodles are usually processed using rice grains of the main crop. There is limited information available on rice noodles processed from rice grains of the ratoon crop. It has been well-documented that the quality (e.g., cooking and texture properties) of rice noodles is closely correlated with the chemical properties of rice grains, such as total starch, amylose, amylopectin, and protein contents [7,9,10], and amylose content is considered as the most important determinant of rice noodle quality [11,12]. In general, the cooked break rate and the cooking loss rate of rice noodles have a negative correlation with amylose content, while hardness and chewiness of rice noodles have a positive correlation with amylose content. There have been studies investigating differences in rice grain amylose content between ratoon and main crops [13–15], but the results are not entirely consistent. Deng et al. [13] and Zhang et al. [15] observed that the rice ratoon crop had significantly higher grain amylose content than the main crop, whereas Kuang et al. [14] reported that the difference in grain amylose content between ratoon and main rice crops was dependent on cultivars and varied from significantly lower, to no significant change, to significantly higher. Moreover, these previous studies only used rice cultivars with low–intermediate amylose content (8–21% or 80–210 mg g^{-1}), most of which are not preferred for manufacturing rice noodles [7].

In the present study, cooking properties and texture profiles of noodles and grain chemical properties of ratoon crops were compared with those of main crops from two rice cultivars that are widely used for processing noodles. The objectives of the present study were to determine the quality characteristics of noodles processed from rice grains of the ratoon crop and identify the related key chemical properties of grains.

2. Materials and Methods

2.1. Experimental Details

Field experiments were conducted at Pingtou Village (28°09′ N, 113°37′ E, 43 m asl), Yongan Town, Liuyang City, Hunan Province, China, in 2020 and 2021. The soil of the experimental field belonged to clay, which had a pH of 6.26, organic matter of 36.7 g kg^{-1}, total N of 1.56 g kg^{-1}, total P of 1.08 g kg^{-1}, total N of 9.79 g kg^{-1}, NaOH-hydrolyzable N of 205 mg kg^{-1}, $NaHCO_3$-extractable P of 35.4 mg kg^{-1}, and NH_4OAc-extractable K of 100 mg kg^{-1} at the 0–20 cm layer before the experiment was begun in 2020.

Two rice cultivars, Guichao 2 and Zhenguiai, were used in the experiment. These two cultivars are *indica* inbreeds and their grains have been widely used for making rice noodles in China. The seeds of Guichao 2 and Zhenguiai were, respectively, provided by the Sichuan Academy of Agricultural Sciences and the Guangxi University.

In each year, Guichao 2 and Zhenguiai were arranged in a completely randomized block design. The experiment was replicated three times with a plot size of 35 m^2. Seedlings were raised on a wet seedbed on 25 March in both 2020 and 2021. Seedlings were manually transplanted on 20 and 26 April in 2020 and 2021, respectively. The transplanting was manually carried out with three seedlings per hill and at a hill spacing of 20 cm × 16.7 cm. N fertilizer (300 kg N ha^{-1}) was applied in five splits: 25% at one day before transplanting, 15% at seven days after transplanting, 10% at panicle initiation, 25% at twenty days after heading of the main crop, and 25% at three days after harvesting the main crop. P fertilizer (75 kg P_2O_5 ha^{-1}) was applied one day before transplanting. K fertilizer (225 kg K_2O ha^{-1}) was applied in three equal split doses at one day before transplanting, panicle initiation, and twenty days after heading of the main crop. The plots were flooded through the whole experimental period with a water depth of 5–10 cm, except that the water was drained for seven days before harvesting main and ratoon crops. The main crop was harvested by hand with a stubble height of about 30 cm above ground. Insects, pathogens, and weeds were controlled using chemicals. Heading and maturity dates and daily mean temperature during the ripening period (i.e., the period from heading to maturity) for each crop of each cultivar in each year are provided in Table 1.

Table 1. Heading and maturity dates and daily mean temperature during the ripening period for main and ratoon crops of two cultivars, Guichao 2 and Zhenguiai, grown in 2020 and 2021.

Cultivar	Main Crop			Ratoon Crop		
	Heading	Maturity	Temperature (°C)	Heading	Maturity	Temperature (°C)
2020						
Guichao 2	11 July	9 August	30.1	27 August	1 October	23.5
Zhenguiai	2 July	2 August	28.9	23 August	28 September	24.2
2021						
Guichao 2	15 July	15 August	29.4	7 September	11 October	26.4
Zhenguiai	10 July	8 August	30.4	3 September	4 October	28.1

2.2. Sampling and Measurements

About 1500 g of rice grains was sampled from each plot for both main and ratoon crops. The rice grain samples were sun-dried, kept at room temperature for three months, and then processed into milled rice.

Approximately 5 g of whole milled rice was ground into flour to determine moisture, starch, amylose, amylopectin, and protein contents. The moisture content was determined by oven-drying at 70 °C to a constant weight. The total starch content was measured with a P850 Pro digital polarimeter (Jinan Hanon Instruments Co., Ltd., Jinan, China). The amylose content was determined by the iodine colorimetric method [16]. The amylopectin was calculated as the difference between the total starch content and the amylose content. The protein content was determined by multiplying N content by a N-to-protein conversion factor of 5.95 [17], where the N content was measured with a Skalar SAN Plus segmented flow analyzer (Skalar Inc., Breda, The Netherlands). The starch, amylose, amylopectin, and protein contents were adjusted to a moisture content of 13.5%.

About 500 g of milled rice was used to process rice noodles with a 5-MFD15B automatic rice-noodle-processing machine (Hunan Fenshifu Machinery Technology Co., Ltd., Loudi, China), according to the procedure described by Huang et al. [10]. Thirty noodles were randomly selected and cut into 20 cm-long sections to determine cooking properties and texture profiles. The noodles were boiled in distilled water for 7 min after weighing. Broken noodles were counted, and solids lost to cooking water were weighed after oven-drying at 105 °C to a constant weight. The cooked break rate (number of broken noodles/total number of noodles × 100) and the cooking loss rate (dry weight of solids lost to the cooking water/weight of uncooked rice noodles) were calculated. A Rapid TA+ texture analyzer (Shanghai Tengba Instrument Technology Co. Ltd., Shanghai, China) was used to determine the texture profiles (hardness, springiness, cohesiveness, resilience, and chewiness) of cooked rice noodles.

2.3. Statistical Analysis

Data were analyzed using analysis of variance (ANOVA), the least significant difference (LSD) test, and Pearson's correlation analysis (Statistix 8.0, Analytical software, Tallahassee, FL, USA). The ANOVA was performed for each cultivar separately, using the statistical model that included replication, crop (main and ratoon), year, and the interaction between crop and year. For parameters that were significantly affected by the interaction between crop and year, the LSD test was employed following the ANOVA to compare means of combinations of two crops and two years. The Pearson's correlation analysis was carried out between selected cooking or texture properties with grain chemical properties for each cultivar, where the selected cooking or texture properties were those that significantly differed between main and ratoon crops in at least one cultivar.

3. Results

3.1. Cooking Properties and Texture Profiles of Rice Noodles

The difference in the cooked break rate of rice noodles was not significant between main and ratoon crops in either Guichao 2 or Zhenguiai (Table 2). In Guichao 2, the cooking loss rate of rice noodles was not significant between main and ratoon crops in 2020 but was significantly lower in the ratoon crop compared with the main crop in 2021. In Zhenguiai, there was no significant difference in the cooking loss rate of rice noodles between main and ratoon crops. Hardness and chewiness of cooked rice noodles were not significantly different between main and ratoon crops in Guichao 2, whereas they were 18% lower in the ratoon crop compared with the main crop in Zhenguiai across two years (Table 3). There were no significant differences in springiness, cohesiveness, or resilience of cooked rice noodles between main and ratoon crops in either Guichao 2 or Zhenguiai.

Table 2. Cooked break rate and cooking loss rate of noodles processed from rice grains of main and ratoon crops of two cultivars, Guichao 2 and Zhenguiai, grown in 2020 and 2021.

Year	Crop	Cooked Break Rate (%)	Cooking Loss Rate (%)
Guichao 2			
2020	Main	0.00	5.36 ± 0.22 b
	Ratoon	0.00	5.98 ± 0.25 b
2021	Main	1.11 ± 1.11	7.09 ± 0.35 a
	Ratoon	1.11 ± 1.11	5.53 ± 0.36 b
Analysis of variance			
Crop		Ns	ns
Year		Ns	ns
Crop × Year		Ns	**
Zhenguiai			
2020	Main	1.11 ± 1.11	5.75 ± 0.26
	Ratoon	3.33 ± 1.92	7.34 ± 0.57
2021	Main	0.00	5.81 ± 0.54
	Ratoon	0.00	5.97 ± 0.30
Analysis of variance			
Crop		Ns	ns
Year		Ns	ns
Crop × Year		Ns	ns

Data are mean ± standard error of three replicates. ns denotes non-significance at the 0.05 probability level. ** denotes significance at the 0.01 probability level. Within a column, means not sharing the same lowercase letter are significantly different according to the LSD test at the 0.05 probability level.

3.2. Chemical Properties in Rice Grains

There was no significant difference in total amylose content in milled rice grains between main and ratoon crops in Guichao 2 (Table 4). The ratoon crop had 4% higher total starch content in milled rice grains compared with the main crop in Zhenguiai in 2020, while the difference was not significant in 2021. Amylose content in milled rice grains was not significantly different between main and ratoon crops in Guichao 2, while the ratoon crop had 3% lower amylose content in milled rice grains than the main crop in Zhenguiai across two years. Amylopectin content in milled rice grains was not significantly different between main and ratoon crops in Guichao 2, whereas amylopectin content in milled rice grains was 4% higher for the ratoon crop compared with the main crop across two years. Protein content in milled rice grains was 10% higher for the ratoon crop than for the main crop in Guichao 2 in 2020, whereas the difference was not significant in 2021. The difference in protein content in milled rice grains was not significant between main and ratoon crops in Zhenguiai in 2020, while in 2021 the ratoon crop had 29% higher protein content in milled rice grains compared with the main crop.

Table 3. Texture profiles of cooked noodles processed from rice grains of main and ratoon crops of two cultivars, Guichao 2 and Zhenguiai, grown in 2020 and 2021.

Year	Crop	Hardness (g)	Springiness	Cohesiveness	Resilience	Chewiness (g)
Guichao 2						
2020	Main	2097 ± 228	0.912 ± 0.001	0.826 ± 0.002	0.602 ± 0.009	1578 ± 170
	Ratoon	1812 ± 209	0.919 ± 0.004	0.849 ± 0.014	0.616 ± 0.009	1410 ± 145
2021	Main	1729 ± 122	0.907 ± 0.002	0.839 ± 0.003	0.590 ± 0.008	1316 ± 93
	Ratoon	2405 ± 173	0.907 ± 0.003	0.821 ± 0.006	0.587 ± 0.010	1787 ± 113
Analysis of variance						
Crop		Ns	ns	ns	ns	ns
Year		Ns	*	ns	ns	ns
Crop × Year		Ns	ns	ns	ns	ns
Zhenguiai						
2020	Main	2854 ± 126	0.910 ± 0.004	0.807 ± 0.007	0.572 ± 0.005	2092 ± 70
	Ratoon	2017 ± 197	0.907 ± 0.002	0.814 ± 0.003	0.584 ± 0.011	1488 ± 143
2021	Main	2522 ± 78	0.910 ± 0.003	0.810 ± 0.004	0.570 ± 0.006	1858 ± 69
	Ratoon	2416 ± 181	0.897 ± 0.004	0.809 ± 0.004	0.572 ± 0.009	1750 ± 117
Analysis of variance						
Crop		*	ns	ns	ns	*
Year		Ns	ns	ns	ns	ns
Crop × Year		Ns	ns	ns	ns	ns

Data are mean ± standard error of three replicates. ns and * denote non-significance and significance at the 0.05 and 0.01 probability level, respectively.

Table 4. Starch and protein contents in milled rice flour of main and ratoon crops of two cultivars, Guichao 2 and Zhenguiai, grown in 2020 and 2021.

Year	Crop	Starch Content (mg g^{-1})			Protein Content (mg g^{-1})
		Total	Amylose	Amylopectin	
Guichao 2					
2020	Main	741 ± 5	265 ± 7	476 ± 7	67.7 ± 0.2 b
	Ratoon	775 ± 4	270 ± 6	505 ± 9	74.3 ± 0.9 a
2021	Main	744 ± 15	262 ± 3	482 ± 12	77.6 ± 2.5 a
	Ratoon	743 ± 1	260 ± 2	484 ± 1	75.4 ± 3.1 a
Analysis of variance					
Crop		Ns	ns	ns	ns
Year		Ns	ns	ns	*
Crop × Year		Ns	ns	ns	*
Zhenguiai					
2020	Main	737 ± 9 b	281 ± 1	456 ± 9	77.0 ± 2.3 bc
	Ratoon	764 ± 5 a	277 ± 3	487 ± 6	81.1 ± 0.7 b
2021	Main	730 ± 7 b	268 ± 4	463 ± 6	72.4 ± 0.2 c
	Ratoon	724 ± 4 b	254 ± 3	470 ± 3	93.3 ± 1.0 a
Analysis of variance					
Crop		Ns	*	*	**
Year		**	**	ns	*
Crop × Year		*	ns	ns	**

Data are mean ± standard error of three replicates. ns denotes non-significance at the 0.05 probability level. * and ** denote significance at the 0.05 and 0.01 probability levels, respectively. Within a column for each cultivar, means not sharing the same lowercase letter are significantly different according to the LSD test at the 0.05 probability level.

3.3. Correlations between Hardness and Chewiness of Cooked Rice Noodles and Chemical Properties in Rice Grains

Hardness and chewiness of cooked rice noodles were not significantly correlated with total starch, amylose, or protein contents in milled rice grains in either Guichao 2 or Zhenguiai (Table 5). There were no significant correlations between hardness and chewiness of cooked rice noodles with amylopectin content in milled rice grains in Guichao 2, whereas hardness and chewiness of cooked rice noodles were significantly negatively correlated with amylopectin content in milled rice grains in Zhenguiai.

Table 5. Pearson's correlation coefficients between hardness and chewiness of cooked rice noodles with total starch, amylose, amylopectin, and protein contents in milled rice flour in two rice cultivars, Guichao 2 and Zhenguiai, grown in 2020 and 2021.

Chemical Properties	Hardness		Chewiness	
	Guichao 2	Zhenguiai	Guichao 2	Zhenguiai
Total starch content	−0.457	−0.644	−0.390	−0.615
Amylose content	−0.530	0.146	−0.469	0.190
Amylopectin content	−0.370	−0.982 *	−0.306	−0.982 *
Protein content	−0.272	−0.291	−0.286	−0.343

* indicates a significant correlation at the 0.05 probability level.

4. Discussion

Prior to the present study, there was limited information about the quality of rice noodles processed from grains of ratoon crops. The results of this study showed that the cooked break rate and the cooking loss rate of rice noodles processed from grains of the ratoon crop were similar to those of the main crop. This finding suggests that rice ratooning does not affect the cooking properties of rice noodles. In addition, this study showed that the change in texture of cooked rice noodles processed from grains of the ratoon crop compared with the main crop varied between cultivars, being significantly softer (i.e., significantly lower hardness and chewiness) in Zhenguiai but not in Guichao 2. This might be partially associated with differences between Guichao 2 and Zhenguiai in the growth and development process and the temperature during the ripening period (Table 1). The results of this study suggest that the effect of rice ratooning on texture properties of rice noodles is dependent on cultivar, indicating that further studies with more cultivars grown under more environments are required to obtain a general understanding of the texture properties of rice noodles processed from ratoon crop grains.

Grain amylose content is an important determinant of the quality of rice noodles, and higher hardness and chewiness of cooked rice noodles are generally associated with higher amylose content in the rice grain [11,12]. In this study, amylose content in milled rice grains of ratoon crops was significantly lower than that of main crops in Zhenguiai. However, this lower amylose content might not be responsible for the lower hardness and chewiness of cooked rice noodles processed from grains of the ratoon crop compared with the main crop in Zhenguiai, because there were no significant correlations between hardness and chewiness of cooked rice noodles with amylose content in rice grains.

More importantly, this study showed that (1) amylopectin content in milled rice grains of the ratoon crop was significantly higher than that of the main crop in Zhenguiai; (2) the hardness and chewiness of cooked rice noodles were significantly negatively correlated with amylopectin content in milled rice grains in Zhenguiai. These results suggest that the lower hardness and chewiness of cooked rice noodles processed from grains of the ratoon crop compared with the main crop in Zhenguiai were attributable to higher amylopectin content in milled rice grains. Grain amylopectin content has been well-documented as a factor affecting the texture of rice products including rice noodles, i.e., higher amylopectin content results in a softer texture [18,19]. Furthermore, there have been reports that the branched-chain length distribution of amylopectin is also essential in determining the texture of rice noodles [20], and rice ratooning can alter the proportion of short and long chains in grain amylopectin [15]. These findings highlight the need for further investigations to determine whether the change in texture of rice noodles processed from grains of the ratoon crop compared with the main crop is associated with a change in amylopectin structure in Zhenguiai.

The advantages of rice-ratooning systems have been widely recognized [1–3]. There are, however, some concerns for newcomers to adopt rice-ratooning systems. In particular, ratoon crops generally have non-uniform heading dates, which may result in inconsistent grain maturity and consequently low head rice recovery, although considerable head rice recovery (55–65%) can be achieved in some rice cultivars [21]. However, this concern is not valid for the rice-ratooning system grown to produce rice grains for processing rice noodles, because broken rice grains can also be used to make rice noodles. We suggest conducting further studies to comprehensively evaluate this special-purpose rice-ratooning system.

5. Conclusions

Rice noodles processed from grains of ratoon crops have similar cooking properties to those processed from grains of main crops in two cultivars (Guichao 2 and Zhenguiai), which are widely used for processing rice noodles. The differences in texture properties (hardness and chewiness) of cooked rice noodles between ratoon and main crops are cultivar-dependent, because they were not significantly different in Guichao 2 but were significantly different in Zhenguiai. Grain amylopectin content is a key chemical property determining differences in texture properties between rice noodles processed from grains of ratoon and main crops. Lower grain amylopectin content is responsible for softer textures of rice noodles processed from grains of the ratoon crop compared with the main crop in Zhenguiai.

Author Contributions: Conceptualization, M.H.; investigation, Z.X., C.L., Y.H., K.Z., J.C., F.C. and S.F.; funding acquisition, M.H. and S.F.; writing—original draft preparation, Z.X. and M.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Joint Fund of the Natural Science Foundation of Hunan Province and the Government of Hengyang City, grant number 2021JJ50076, and the National Key R&D Program of China, grant number 2016YFD0300509.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Xu, F.; Zhang, L.; Zhou, X.; Guo, X.; Zhu, Y.; Liu, M.; Xiong, H.; Jiang, P. The ratoon rice system with high yield and high efficiency in China: Progress, trend of theory and technology. *Field Crops Res.* **2021**, *272*, 108282. [CrossRef]
2. Henry, A. Rice ratooning makes a comeback. *Rice Today* **2020**. Available online: https://ricetoday.irri.org/rice-ratooning-makes-a-comeback (accessed on 2 November 2022).
3. Wang, W.; He, A.; Jiang, G.; Sun, H.; Jiang, M.; Man, J.; Ling, X.; Cui, K.; Huang, J.; Peng, S.; et al. Ratoon rice technology: A green and resource-efficiency way for rice production. *Adv. Agron.* **2020**, *159*, 135–167.
4. Cruz, M.; Arbelaez, J.D.; Loaiza, K.; Cuasquer, J.; Rosas, J.; Graterol, E. Genetic and phenotypic characterization of rice grain quality traits to define research strategies for improving appearance, and cooking quality in Latin America and the Caribbean. *Plant Genome* **2021**, *14*, e20134. [CrossRef]
5. Lau, W.C.P.; Latif, M.A.; Rafii, M.Y.; Ismail, M.R.; Puteh, A. Advances to improve the eating and cooking qualities of rice by marker-assisted breeding. *Crit. Rev. Biotechnol.* **2016**, *36*, 87–98.
6. Huang, M.; Hu, L. Low glycemic index: The next target for rice production in China? *J. Integr. Agric.* **2021**, *20*, 1727–1729. [CrossRef]
7. Low, Y.K.; Effarizah, M.E.; Cheng, L.H. Factors influencing rice noodles qualities. *Food Rev. Int.* **2020**, *36*, 781–794. [CrossRef]
8. Li, Y.; Liang, J.F.; Yang, M.Y.; Chen, J.Y.; Han, B.Z. Traditional Chinese rice noodles: History, classification, and processing methods. *Cereal Foods World* **2015**, *60*, 123–127. [CrossRef]
9. Geng, D.; Zhou, S.; Wang, L.; Zhou, X.; Liu, L.; Lin, Z.; Qin, W.; Liu, L.; Tong, L. Effects of slight milling combined with cellulase enzymatic treatment on the textural and nutritional properties of brown rice noodles. *LWT Food Sci. Technol.* **2020**, *128*, 109520. [CrossRef]
10. Huang, M.; Xiao, Z.; Chen, J.; Cao, F. Yield and quality of brown rice noodles processed from early-season rice grains. *Sci. Rep.* **2021**, *11*, 1–6.
11. Bhattacharya, M.; Zee, S.Y.; Corke, H. Physicochemical properties related to quality of rice noodles. *Cereal Chem.* **1999**, *76*, 861–867. [CrossRef]

12. Fari, M.J.M.; Rajapaksa, D.; Ranaweera, K.K.D.S. Quality characteristics of noodles made from selected varieties of Sri Lankan rice with different physiochemical characteristics. *J. Natl. Sci. Found. Sri Lanka* **2011**, *39*, 53–60. [CrossRef]
13. Deng, F.; Yang, F.; Li, Q.; Zeng, Y.; Li, B.; Zhong, X.; Lu, H.; Wang, L.; Chen, H.; Chen, Y.; et al. Differences in starch structural and physiochemical properties and texture characteristics of cooked rice between the main crop and ratoon rice. *Food Hydrocoll.* **2021**, *116*, 106643. [CrossRef]
14. Kuang, N.; Zheng, H.; Tang, Q.; Chen, Y.; Wang, X.; Luo, Y. Amylose content, morphology, crystal structure, and thermal properties of starch grains in main and ratoon rice crops. *Phyton Int. J. Exp. Bot.* **2021**, *90*, 1119–1230. [CrossRef]
15. Zhang, W.; Luo, X.; Zhan, Z.; Shu, Z.; Wang, P.; Ding, W.; Zeng, X.; Shi, Y. Comparison of the structural and functional properties of starches in rice from main and ratoon crops. *J. Cereal Sci.* **2021**, *99*, 103233. [CrossRef]
16. Huang, M.; Jiang, L.; Zou, Y.; Zhang, W. On-farm assessment of effect of low temperature at seedling stage on early-season rice quality. *Field Crops Res.* **2013**, *141*, 63–68. [CrossRef]
17. Juliano, B.O.; Bressani, R.; Elias, L.G. Evaluation of the protein quality and milled rices differing in protein content. *J. Agric. Food Chem.* **1971**, *19*, 1028–1034. [CrossRef]
18. Aoki, N.; Umemoto, T.; Hamada, S.; Suzuki, K.; Suzuki, Y. The amylose content and amylopectin structure affect the shape and hardness of rice bread. *J. Appl. Glycosci.* **2012**, *59*, 75–82. [CrossRef]
19. Zhou, X.; Peng, C.; Zhang, Y.; Guo, L.; Xiong, N. Factors influencing gel texture and eating quality of pressed type fresh rice noodles. *Food Sci.* **2017**, *38*, 93–99.
20. Kang, T.; Yoon, M.; Lee, J.; Choi, K. Branched chain length distribution of amylopectin in rice flour as a key attribute for determining the quality of extruded rice noodles. *J. Food Process. Preserv.* **2022**, *46*, e16473. [CrossRef]
21. Wang, Y.; Li, X.; Tarpley, L.; Peng, S.; Dou, F. Effects of nitrogen management on the ratoon crop yield and head rice yield in South USA. *J. Integr. Agric.* **2021**, *20*, 1457–1464. [CrossRef]