Consumer's acceptability of rice-like grains made from cassava (Manihot esculenta Crantz) and corn (Zea mays)

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Rice is one of the most important crops in Asia. Several crops were explored as rice alternatives to reduce the burden of importation and improve food security. The purpose of this study was to develop a consumer acceptable rice-like grain from cassava and corn. Four (4) cassava varieties were combined with five (5) corn varieties at eleven (11) ratio levels, making a total of 220 combinations. The most acceptable ratios for each cassava-corn combination (n=19) were then subjected to consumer acceptability testing. Results showed that the five most acceptable combinations are Lakan 2-IPB Var 8, Binulak-IPB Var 8, Binulak-IPB Var 6, Lakan 2-IPB Var 13, and Rajah 4-IPB Var 6. Eighty-two per cent (82 %) of the respondents (n=120) preferred Lakan 2-IPB Var 13. These were also perceived as the most comparable and acceptable to rice (r=0.753; p<0.01). The study revealed that production of rice-like grains from other staples could potentially be an alternative to rice. Further studies may be done to improve the process, thus making the product more similar to rice.

1. Introduction

Rice is considered a staple food in the Philippines. The country's rapid population growth increased rice demand and the need to import rice over the past decade (Tibao, 2009). A study done by Francisco and his associates (2013) revealed that there is an increasing trend in the per capita rice consumption in the Philippines. Rice supplies up to 50% of the dietary caloric intake in populations living in poverty, making rice a critical factor for food security (Muthayya et al., 2014). There are several strategies done to ensure food security in Asia, such as macro policy reforms, agricultural and rural development policies, and interventions to improve poverty (FAO, 1999). However, there seems to be some disconnect in these strategies, and rice policy was the most distinct. While high prices for rice farmers are carried out to help reduce poverty, these high prices affect poor consumers the most (Timmer, 2013). This, in turn, sets a demand for cheaper alternatives to rice (Pandey et al., 2010). Other carbohydrate-rich crops, however, cannot compete with rice because of its distinct grain quality, colour, and aroma (Custodio et al., 2019).

Child undernutrition is a prevailing public health concern in developing countries. Children belonging to food-insecure households were more likely to

be stunted and underweight (Ali et al., 2013). It was found that one in three 2-year old children are irreversibly stunted, whereas there is a 30% stunting prevalence rate among 3 to 4-year old children (UNICEF, 2019). Barangay Dayap, Calauan ranks second to the twenty (20) most vulnerable barangays (district)in the province of Laguna, Philippines, based on hazard exposure such as the occurrence of typhoons and flooding events; and human, infrastructure, and livelihood sensitivity based on poverty rates, malnutrition, and involvement in agriculture. Barangay Dayap belongs to the lowland topographical classification, has one of the highest malnutrition rates, and has a low adaptive capacity based on technological, social, and human indicators (Mendoza et al., 2014). Furthermore, households in rural areas are heavy consumers of traditional staples, unlike urban households who tend to rely on fast food diets (Catelo, 2004).

Fervent measures must be done to improve the nutritional status of children, and one strategy is to improve the nutritional quality of staples. Efforts to increase the nutritive value of rice are made by developing rice analogues through extrusion—processing rice and fortifying it with minerals such as zinc and iron, others with vitamin A (Mishra et al., 2012). Peñaflor and his colleagues (2014), developed rice-like grains from broken rice and adlai (Job's tears) to utilise the broken rice and increase the nutritional value by adding the adlai. Cassava has much potential as a staple because not only does it contain high levels of carbohydrates, it also has calcium, iron, potassium, magnesium, zinc, copper and manganese. Beta-carotene was also observed in yellow-fleshed cassava, such as that of Lakan 1 variety (Montagnac et al., 2009; UPLB, 2018). White fleshed cassava varieties include Lakan 2 and Rajah 4 (UPLB, 2018; Mamaril et al., 2007).

On the other hand, corn is a vital source of starch and even non-starch polysaccharides. It also contains proteins and fat. The role of corn in human nutrition is also gaining much attention (Yongfeng & Jay-lin, 2016). Quality protein maize (QPM) is a corn variety that is high in both lysine and tryptophan; two of the essential amino acids (Ahenkora et al., 1999). IPB Var 6 is a white quality protein maize developed by the Institute of Plant Breeding (IPB), University of the Philippines Los Baños (UPLB, 2018). Other varieties developed by IPB are IPB Var 8 (white corn), IPB Var 11 (yellow) and Var 13 (yellow). Also, Camotes

(CGUARD N68), a pigmented corn variety native of the Philippines, was found to increase the levels of antioxidant activity, as well as dietary fibre and zinc in crackers (Sales et al., 2018). These properties indicate that both cassava and corn are good candidates as alternative staples, all the more if they are combined as one product. The goal of this study was to develop rice-like grains from composites of cassava and corn. Moreover, it aimed to determine the consumer acceptability of these rice-like grains. Sensory evaluation was the basis for choosing combinations for consumer acceptability.

2. Materials and Methods

2.1. Preliminary study: Development of rice-like grains

Four varieties of cassava from the Institute of Plant Breeding, University of the Philippines Los Baños and Visayas State University, Leyte namely Lakan 1, Lakan 2, Binulak and Rajah 4 were used in the study. These were combined with different varieties of corn— IPB Var 6, IPB Var 8, IPB Var 11, IPB Var 13 and Camotes. Eleven (11) cassava-corn composites (100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90, and 0:100) for each paired combination were made into rice-like grains, making a total of two-hundred twenty (220) combinations. The rice-like grains were prepared similar to that of Hurtada et al. (2020) and Escobar (1992). The rice-like grains were prepared by mixing 100g flour composite with 30g egg white and 45mL distilled water. The dough was then placed in a pasta maker and cut into 10-mm pieces. The product was then steamed and dried. After which, the dried pellets were subjected to the Satake mill, an abrasive mill used to achieve the rice-like shape. Formulations that formed dough and retained their discreet rice-like grain shape when cooked were considered for sensory evaluation.

Sensory evaluation served as the basis for the selection of rice-like grains for consumer studies. According to Watts et al. (1989), in-house consumer panels usually consist of 30 to 50 untrained panellists. In this study, forty-five (45) volunteers were recruited for each combination and employed a completely randomised design for a sample presentation. The panellists were recruited based on age criteria (20-45 years old) and that they were not experiencing any illness

such as coughs, colds, or sore throat at the time of the study. The evaluation was carried out in a well-lit room where fifteen (15) grams or one tablespoon of boiled rice-like grains was served in small plastic cup containers. The panellists evaluated eleven (11) coded and randomised samples which were divided into three sessions. Panellists were provided with a glass of water and were instructed to rinse and swallow water between samples. Before sensory evaluation, interested panellists were given an informed consent form. Panellists were asked to evaluate the sensory characteristics (colour, aroma, texture and flavour) and overall liking of each sample. The sensory evaluation method used was a 15-cm line scale, as indicated by Lawless and Heymann (2003). Anchors used for each attribute are the following; (1) Colour – white to golden yellow; (2) Aroma – bland to strong; (3) Texture – sticky to firm; and (4) Flavour – starchy to cooked rice. On the other hand, the overall liking of the sample ranged from dislike to like.

2.2. Consumer acceptability

A cross-sectional study was carried at the community hall of Barangay Dayap, Calauan, Laguna, which included consumer testing of rice-like grains. The study was done in four consecutive days. One-hundred twenty (120) adult panellists were recruited from the said barangay. Criteria of panellists that were included in the study were: (1) should be of legal age; (2) were mothers or caregivers with pre-school children; (3) did not have any allergies to cassava, corn and egg; and (4) should be a resident of Barangay Dayap. Before the sensory evaluation, panellists were asked to sign an informed consent form explaining the nature of the study, voluntary participation, and non-disclosure of any identifying information.

The most acceptable ratios for each cassava-corn varietal combination (19) were used in consumer acceptability. Coded samples were randomly presented, four products a at time. Consumers rated acceptability for four (4) sensory attributes including colour, aroma, texture, and flavour using a 5-point hedonic scale. Acceptability was further evaluated using a binomial scale (yes or no) based on the following parameters: overall acceptability, comparability with rice, household preference, and their willingness to purchase. The perceived selling price of the respondents was also determined.

2.3. Statistical analysis

Data gathered from sensory evaluation and consumer testing were analysed using Analysis of Variance (ANOVA) and Kruskal Wallis, respectively. Whereas descriptive analysis was used for the demographic data. If the treatments were significant, Tukey's studentised range test and Bonferroni test were employed for further data analysis at 5% level of significance. Lastly, the relationship of consumer preference, willingness to pay, and the perceived price was determined using Spearman correlation. All statistical data were processed using the SPSS version 20 software.

3. Results and Discussion

3.1. Preliminary Study: Acceptability of rice-like grains

3.1.1. Binulak and different corn combinations

Rice-like grains made from the combination of Binulak and different varieties of corn are illustrated in Figure 1. For Binulak and Camotes combination, the ratio with the highest degree of liking is that of 80:20, whereas, pure Camotes had the lowest acceptability rating. This result indicates that for Binulak-Camotes rice-like grains, the overall liking seems to decrease as the proportion of Camotes increases. It was also noted that the overall likability of Binulak and Camotes combination had a positively weak association with its flavour. However, only the flavour exhibited a significant association among the sensory characteristics.

With IPB Var 6 corn, panellists still perceived a lower degree of liking as the corn proportion increased, the lowest liking was that of 10:90 combination and the highest for 50:50 of Binulak and IPB Var 6 grains. For this combination, it was found that colour (r=0.247, p<0.01), texture (r=-0.275, p<0.01), and flavour (r=0.509, p<0.01) had a positively weak, negatively weak and positively moderate correlation with overall likability, respectively. The findings suggest that for Binulak and IPB Var 6 combinations, grains close to golden yellow in colour, slightly less firm, and with cooked rice flavour were more liked by panellists.

Grains of Binulak and IPB Var 8 had the highest overall likability 80:20 proportion and lowest at 30:70.

Correlation revealed that texture (r=0.114, p<0.01) and flavour (r=0.349, p<0.01) are the characteristics that are significantly related to the overall likability of Binulak and IPB Var 8 blends. On the other hand, the blend of 90:10 Binulak and IPB Var 11 was most liked by the panellists and 50:50 the least liked. A very weak relationship between aroma (r=0.161, p<0.01) and overall likability was realised for Binulak and IPB Var 11. Similar findings were observed with texture (r=0.101, p<0.05). In addition, higher acceptability was noted with samples having a flavour close to that of cooked rice (r=0.411, p<0.01). In the same way, blends with IPB Var 13 also revealed that grains that have firmer texture (r=0.161, p<0.01), stronger aroma (r=0.111, p<0.05), and closer to that of cooked rice flavour (r=143, p<0.01) were more likeable. The combination with the highest likability was 80:20 while 20:80 was the lowest.

3.1.2. Lakan 1 and different corn combinations

Among the varieties of corn combined with Lakan 1, the blend with IPB Var 8 had the highest degree of liking (Figure 2). For Lakan 1 and Camotes combination, a decreasing likability was observed as the proportion of corn increased. One hundred per cent (100 %) Lakan 1 had the highest degree of liking, followed by the blend with 20% Camotes. The overall likability of Lakan1 and Camotes blend is significantly (p<0.01) related to all the sensory attributes tested showing that a less white (r=0.406), strong aroma (r=0.311), less firm texture (r=-0.246), and cooked rice flavour (r=0.158) had a higher degree of liking.

On the other hand, for the blends with IPB Var 6, 60:40 combination had the highest likability rating with colour (r=0.137, p<0.01), aroma (r=0.154, p<0.01), and flavour (r=0.384, p<0.01) having a significant positive correlation. A decreasing likability trend was also seen in blends with IPB Var 11, with 90:10 cassava to corn ratio the highest, while 90:10 for blends with IPB Var 13. Whereas, the 50:50 combination garnered the most acceptable rating for blends of Lakan 1 and IPB Var 8.
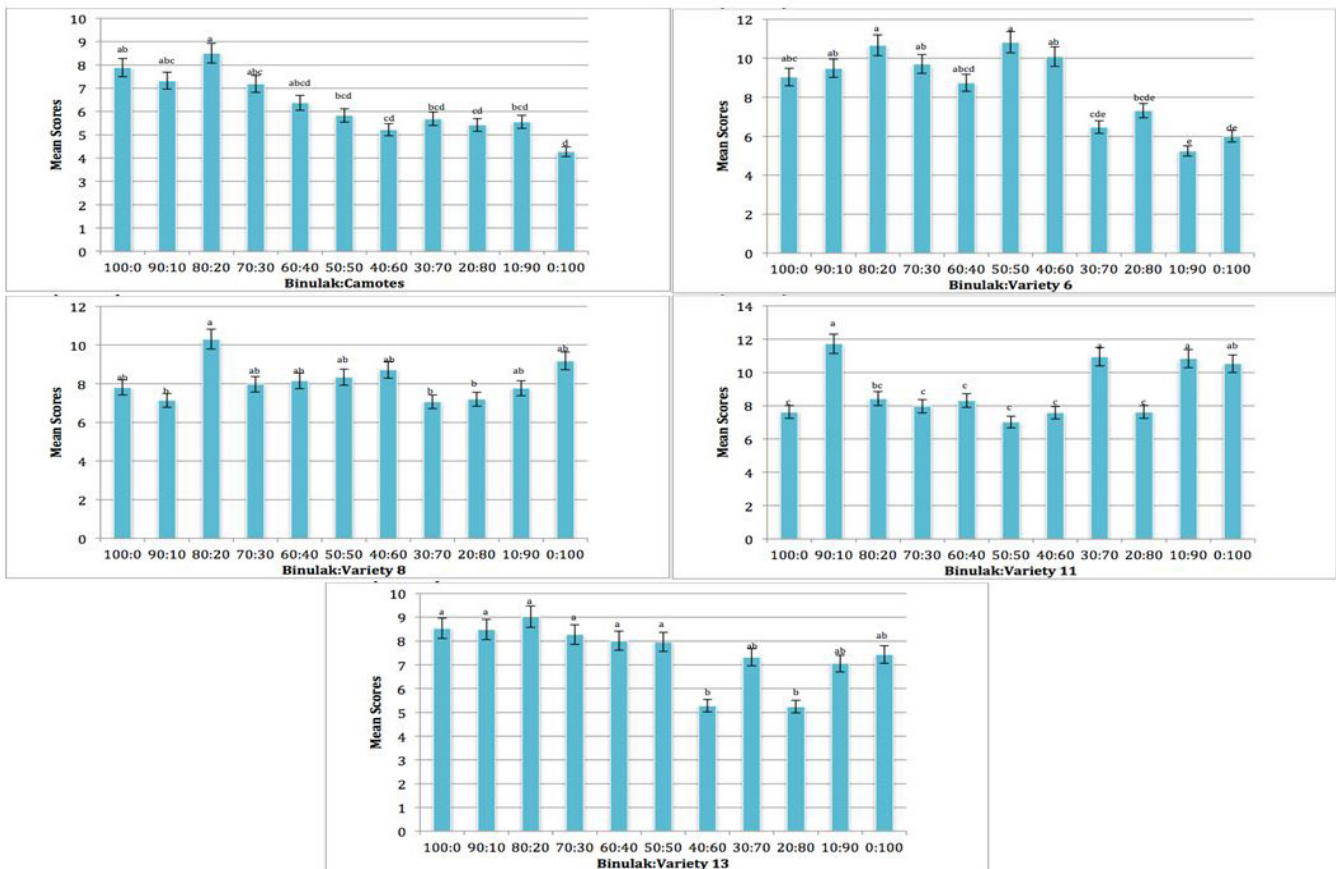

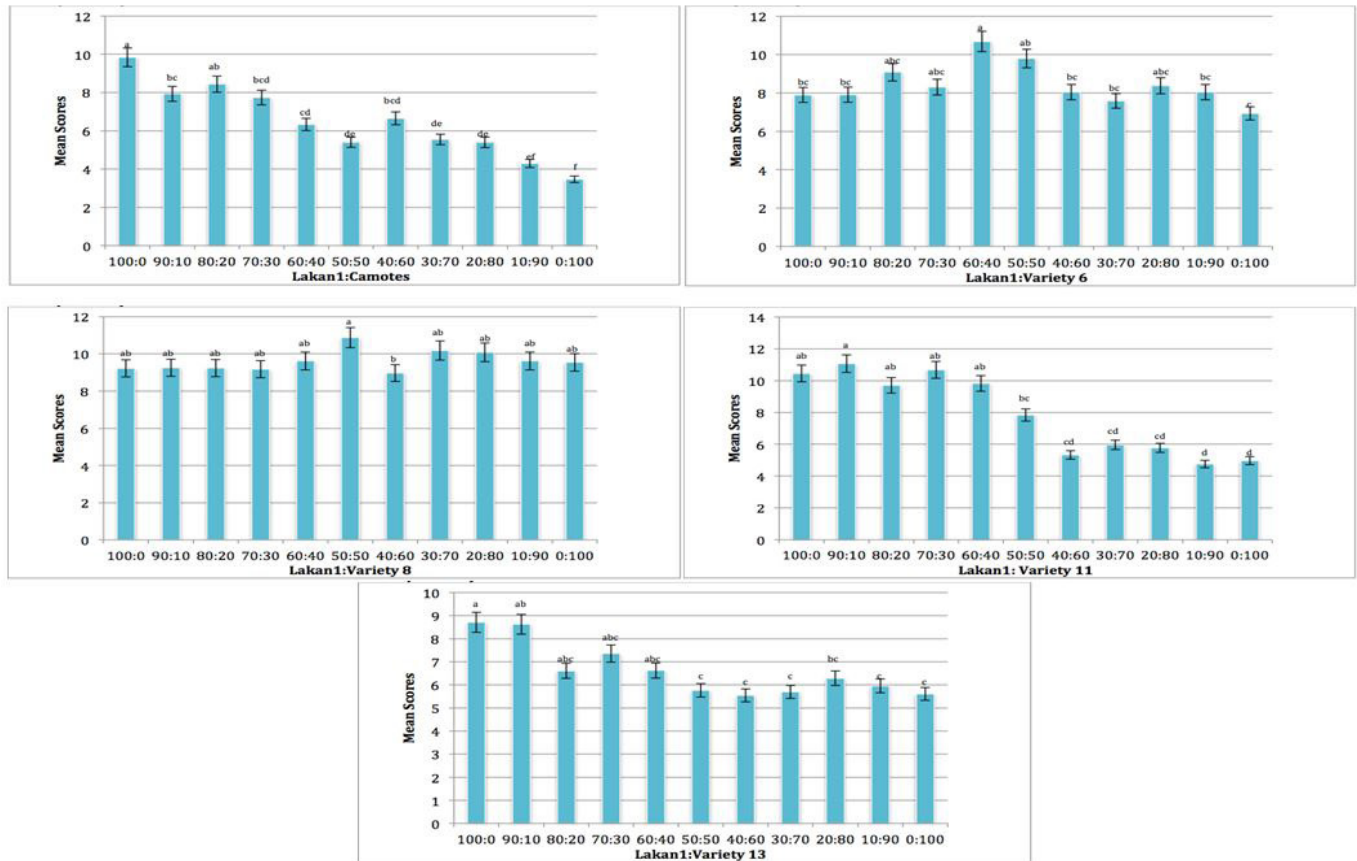**Figure 1.** Over-all likability of Binulak rice-like grains

Figure 2. Overall likability of Lakan 1 rice-like grains

3.1.3. Lakan 2 and different corn combinations

Figure 3 shows the overall acceptability of Lakan 2 combinations. It was noted that higher amounts of Lakan 2 had a higher degree of liking compared to those with high corn proportions. For the blends with Camotes corn, 90:10 Lakan 2 and Camotes combination had the highest likability score where panellists perceived that a flavour close to the cooked rice (r=0.359, p<0.01) was more likeable. Similarly, combining Lakan 2 with IPB Var 13 also resulted in 90:10 being the most likeable blend with all attributes significantly correlated with overall likability. A whiter (r=-0.125, p<0.01), more aromatic (r=0.271, p<0.01), softer (r=-0.229, p<0.01), and stronger cooked rice flavour (r=0.381, p<0.01) were considered more likeable by the panellists.

Twenty per cent (20 %) Variety 11, on the other hand, turned out to have the highest likability among its blends. The same results as Lakan 2 and IPB Var 13 combination were generated for the correlation of likability with the sensory attributes tested. For blends

with IPB Var 6, 70:30 was rated as most likeable, where more golden yellow colour (r=0.306, p<0.01), softer texture (r=-0.354, p<0.01), and less starchy flavour (r=0.422, p<0.01) of cooked grains were regarded as more acceptable. Conversely, it was 40:60 Lakan 2 and IPB Var 8 combination with the highest degree of liking for the blends of IPB Var 8 while 50:50 ratio was most liked for Lakan 2 and IPB Var 11 combination.

3.1.4. Rajah 4 and different corn combinations

Camotes and Rajah 4 combination showed that the more corn was added, the least the grains were liked (Figure 4). The 80:20 combination of cassava and corn had the highest degree of liking, and all sensory attributes were significantly related to overall likability (p<0.01). Whereas for grains with IPB Var 6, only colour (r=0.098, p<0.05) and flavour (r=0.467, p<0.01) were related to the overall likability of the blends, indicating that grains closer to golden yellow and cooked rice flavour were more acceptable. Grains with 100% Rajah 4 were most acceptable followed by their 90:10, cassava and IPB Var 6, combination.

Comparable to Rajah 4 and Camotes combination, blends with IPB Var 8 also resulted in 80:20 having the highest degree of liking. It showed that a less white (r=0.327, p<0.01), softer texture (r=-0.170, p<0.01), and closer to cooked rice flavour (r=0.202, p<0.01) grains were more likeable. On the contrary, all sensory attributes were related to overall likability for blends with IPB Var 13, namely colour (r=0.251, p<0.01), aroma (r=0.307, p<0.01), texture (r=0.371, p<0.01), and flavour (r=0.537, p<0.01). Also, 70:30, Rajah 4 and IPB Var 13 had the highest mean score for acceptability. For Rajah 4 and IPB Var 11 combination, a higher corn proportion that was 40:60 was the most acceptable. Interestingly, this ration was the reverse from all other blends.

3.2. Consumer's acceptability of rice-like grains

3.2.1. Profile of respondents

A total of 120 rice-consuming mothers and caregivers of pre-school children participated in the study. Almost all of the respondents were female (99.2 %). The age of the mothers and caregivers largely varied as half of them (50 %) were above 40 years old, 31 out of 120 (26%) were between 31 to 40 years old, 27 out of 120 (23 %) were between 21 to 30 years old, and only two of them were under 20 years old. About thirty-eight per cent (38 %) of them belong to a household composed of five to six members, and about thirty per cent (30 %) belong to a household of three to four members. The majority of the respondents (61 %) have an average monthly income of less than €87 (Php 5,000), while 32 of 120 (27 %) have an average monthly income of €87 to €174 (Php5,000 to Php10,000). Despite the majority of the population belonging to a large household size with low average monthly income, eighty-two per cent (82 %) of the households eat rice thrice a day.

3.2.2. Degree of liking of sensory attributes

Rice-like grains with the highest acceptability scores for each cassava-corn combination were subject to consumer testing. The degree of liking of the attributes colour, aroma, texture, and flavour was determined
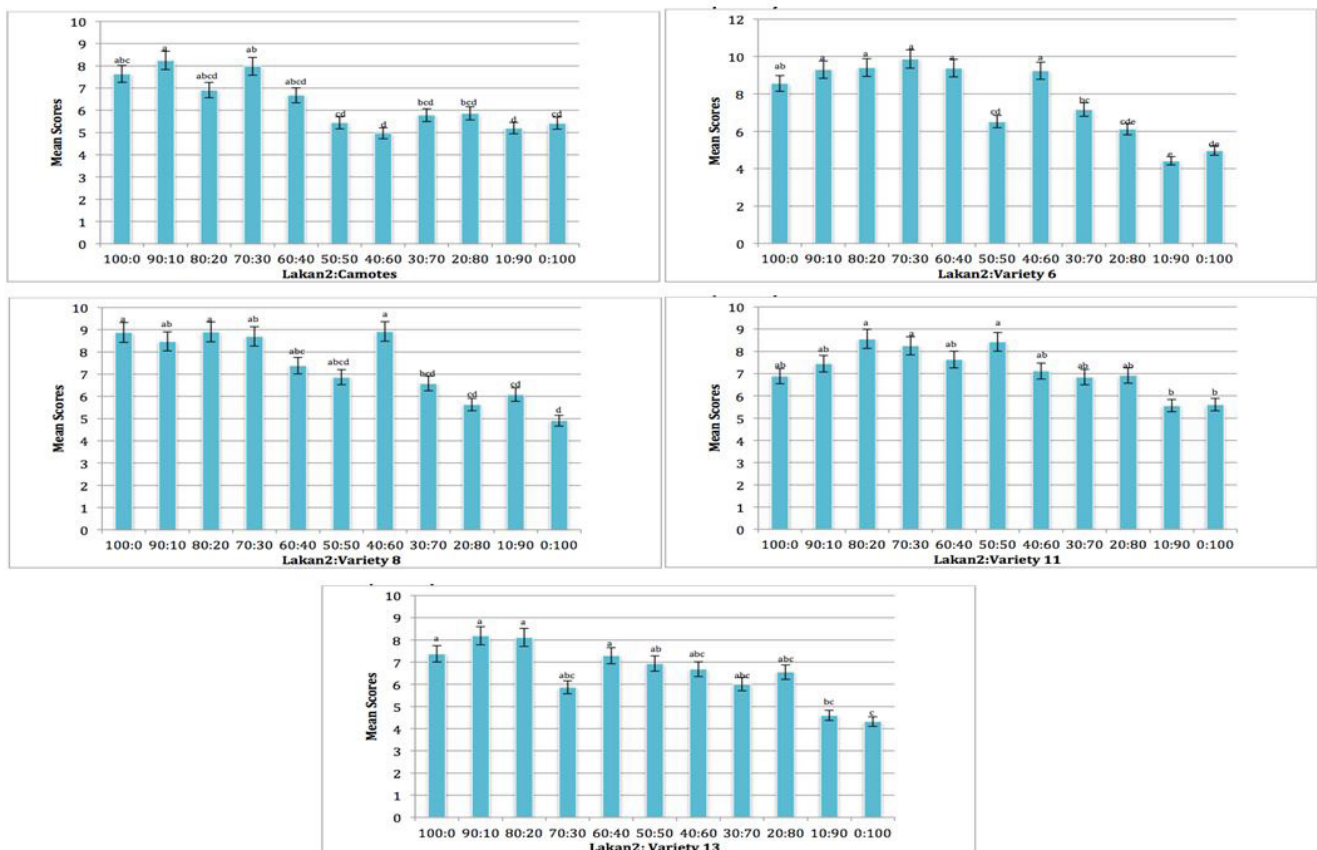

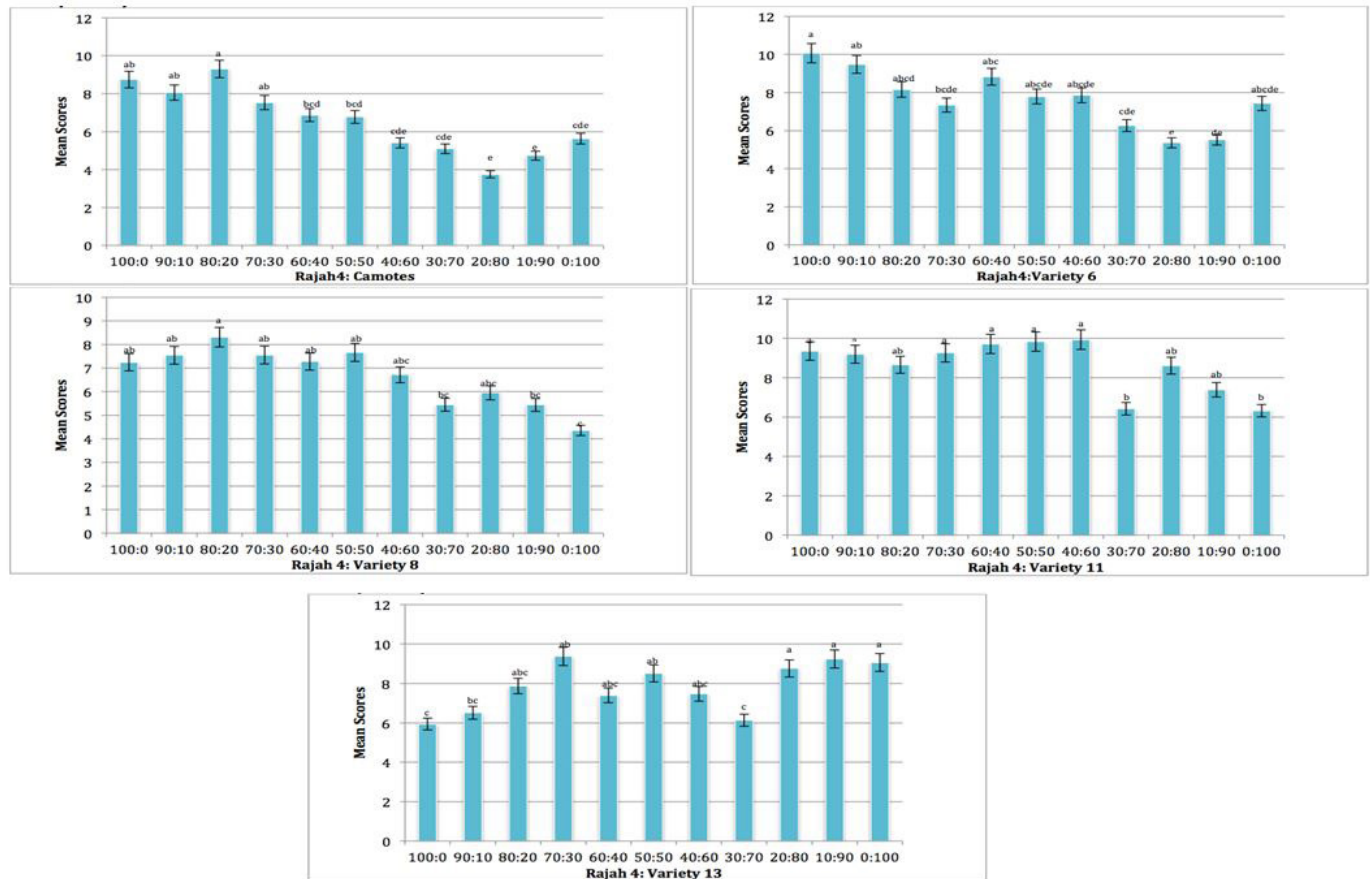**Figure 3.** Over-all likability of Lakan 2 rice-like grains

Figure 4. Over-all likability of Rajah 4 rice-like grains

using a 5-point hedonic scale (Table 1). Consumers usually assess the initial quality of a product by its colour and appearance, thus colour or appearance are the primary indicators of perceived quality (Lawless & Heymann, 2010). In rice quality, whiteness and translucency are important, with whiteness ranging from white to yellow. The whiteness of rice increases sharply during milling, while yellowness occurs during ageing (IRRI, 2006; Juliano et al., 2004).

Interestingly, for rice-like grains, the combination that ranked highest (mean rank =1384.80) in colour likability is a mix of white-fleshed cassava (Lakan2) and yellow corn (IPB Var13). In terms of aroma, Binulak: IPB Var 6 had the highest mean rank likability score (mean rank =1335.28) while Rajah 4 and Camotes combination significantly ranked the lowest among all treatments (p<0.05). The high likability score may be attributed to the strong aroma of the Binulak cassava when cooked (Hurtada et al.., 2020). Findings of the study done by Somthawil and Sriwattana (2016) concur, stating that strong aroma in rice coincided with high acceptance scores.

The aroma of cooked rice may be described as hay-like or musty, popcorn, corn, beany, dairy, sweet-aromatic, grassy, vanilla, sewer, animal, metallic and floral (IRRI, 2006). The Lakan2: IPB Var 13 combination scored the highest rank in texture likability (mean rank=1366.67). Texture is described as what is experienced in the mouth when eating rice. Stickiness, roughness, and springiness are the major traits that distinguish the texture of rice (Champagne et al., 2010). The most acceptable combination in terms of flavour is the mix of Binulak and IPB Var 6 (mean rank =1354.84) as well as the aroma. Aroma and flavour are significantly related attributes (Lawless and Heymann, 2010). Flavour in fragrant rice is produced by volatile compounds, many of which are volatilised during cooking to produce an aroma. Other sensory descriptors for rice are cardboard-like, starchy, metallic, and over-all rice impression (Meullenet et al., 2000). The lowest-ranked were Rajah 4: Camotes and Binulak: IPB Var 11. Common characteristics shared by Rajah 4: Camotes and Binulak: IPB Var11 were hardness and colour of grains. Products were described as hard ("matigas") and uneven coloured ("hindi pare-pareho ang kulay").

Table 1. The mean rank scores of the consumer degree of liking for the sensory attributes of cooked rice-like grains

Combination	Colour	Aroma	Texture	Flavour
Lakan1: IPBVar6	1089.09[bcd]	1159.50[bcdefg]	1204.62[fgh]	1169.19[cdef]
Lakan1: IPBVar8	1072.94[bc]	1085.20[abcde]	1161.40[bcdefg]	1056.65[bcde]
Lakan1: IPBVar11	1107.70[cde]	1088.43[abcde]	1172.40[bcdefg]	1182.66[cdef]
Lakan1: IPBVar13	931.73[b]	1038.19[abcd]	1087.01[bcdef]	1046.55[bcd]
Lakan1: Camotes	1200.57[cdef]	1173.81[defg]	1194.89[defgh]	1191.14[def]
Lakan2: IPBVar6	1116.35[cde]	1189.93[defgh]	1099.05[bcdefg]	1142.68[bcde]
Lakan2: IPBVar8	1253.72[efg]	1177.74[defgh]	1240.23[fgh]	1188.22[def]
Lakan2: IPBVar11	948.43[b]	1008.85[ab]	1041.72[bcde]	1029.64[bc]
Lakan2: IPBVar13	1384.80[g]	1293.38[gh]	1366.67[i]	1312.96[fg]
Lakan2: Camotes	1076.79[bc]	1209.65[efgh]	1197.35[efgh]	1143.30[bcde]
Rajah4: IPBVar6	1158.15[cde]	1146.57[bcdefg]	1187.48[cdefgh]	1207.82[efg]
Rajah4: IPBVar8	1216.56[cdef]	1250.26[fgh]	1333.16[hi]	1310.60[fg]
Rajah4: IPBVar13	1243.61[defg]	1108.78[bcdef]	1099.86[bcdefg]	1156.45[cde]
Rajah4: IPBVar11	1127.54[cde]	1124.03[bcdef]	1022.60[b]	1096.35[bcde]
Rajah4: Camotes	769.82[a]	944.61[a]	1031.36[bc]	987.42[b]
Binulak: IPBVar6	1335.28[fg]	1318.23[h]	1247.91[ghi]	1354.82[g]
Binulak: IPBVar8	1355.43[fg]	1204.45[efgh]	1131.72[bcdefg]	1127.75[bcde]
Binulak: IPBVar11	1072.41[bc]	1016.62[abc]	812.43[a]	841.45[a]
Binulak: Camotes	1208.60[cdef]	1131.27[bcdef]	1037.63[bcd]	1123.84[bcde]

[a-i] Mean scores with the same letter within the same column are not significantly different using Bonferroni test (p<0.05).

3.3. Relationship of acceptability, willingness to purchase, household preference, and perceived price

Based on overall acceptability, the majority (81.7 %) of the respondents preferred Lakan 2: IPB Var 13 (90:10) over the other combinations. It was the same sample that gave the highest score in terms of comparable characteristics to rice. Descriptors used were delicious ("masarap") and tastes and smells like rice ("amoy at lasang kanin"). However, when asked if other household members will consume the product, Binulak: IPB Var 6 (50:50) was favoured by most (78.3 %). Furthermore, about eighty-seven per cent (87 %) of them chose to buy the same sample. In general, characteris-

tics preferred by the respondents were rice-like grains which were lighter in colour, softer and fluffier in texture, with a slightly bland taste. Rajah 4: Camotes (80:20) produced unevenly coloured grains, some appearing darker.

Figure 5 illustrates the relationship between acceptability scores, willingness to purchase, household preference, and perceived price. A strong positive correlation was realised between colour and aroma (r=0.700, p<0.01); and between flavour and texture (r=0.716, p<0.01). In terms of acceptability parameters, a strong positive correlation was found between overall acceptability and its comparability to rice (r=0.753, p<0.01). A moderately strong positive correlation exists between overall acceptability and individual

sensory attributes such as colour (r=0.467, p<0.01), aroma (r=0.468, p<0.01), texture (r=0.533, p<0.01), and flavour (r=0.583, p<0.01). Likewise, a moderately strong positive correlation was observed between comparability to rice and all sensory attributes. All sensory attributes shared a moderate to strong positive correlation which means consumers take colour, aroma, texture, and flavour as one. Additionally, the strong positive correlation between overall acceptability and comparability with rice implies that the consumers rated the product's acceptability based on the similarities to rice. Filipinos share a general preference to rice in which it should be long-grained, translucent, white, well-milled, aromatic, and soft when cooked (Juliano et al., 2004; de Leon, 2005).

There was also a strong positive correlation between the perceived household preference and willingness to purchase (r=0.779, p<0.01). Mothers and caregivers were more likely to purchase what they thought the household prefers (r=0.779, p<0.01) over personal liking, as evidenced by a weak positive correlation (r=0.177, p<0.01). However, it must be noted that both parameters remained significant. Household food decision-making is a joint activity determined by family dynamics and how active children participate in the process (Hall et al., 1995; Noorgard et al., 2007). The overall acceptability among mothers and caregivers contributes to the potential marketability of the product. However, the household acceptability of the product is of more vital importance.

The price-quality relationship can be discussed based on two viewpoints; one is based on consumer perception and the other on market positioning (Judd, 2000). In terms of perceived price, a high value (>€0.87) meant that the product was deemed of higher quality, while a low value (<€0.52) meant that the product was deemed of lesser quality. In Metro Manila, rice of higher quality and price are the dinorado and milagrosa varieties, while rice from the Philippine National Food Authority was known to be the cheaper alternative (Aguilar, 2005). Such varieties commonly found in markets were expected to serve as benchmarks.

There was a weak positive correlation between price and all sensory attributes. Quality can be translated to sensory attributes such as colour, aroma, texture, and flavour. Among all sensory attributes, colour had the highest positive correlation with price (r=0.094, p<0.01). However, there was no significant relationship between perceived price and overall acceptability as well as the comparability to rice. Based on the lack of significant correlation, it can be inferred that the rice-like grains were taken as a new product rather than as a substitute. The perceived price weakly reflects quality in terms of sensory attributes. While perceived price, in this study, cannot be used as an indicator of overall acceptability. Binulak: IPB Var 6 was perceived to be comparable to the cost of rice, which was between €0.52 to €0.87 (Php30 to Php50). On the other hand, cassava rice-like grains with Rajah 4 show a low perceived cost of fewer than €0.52 (Php30).
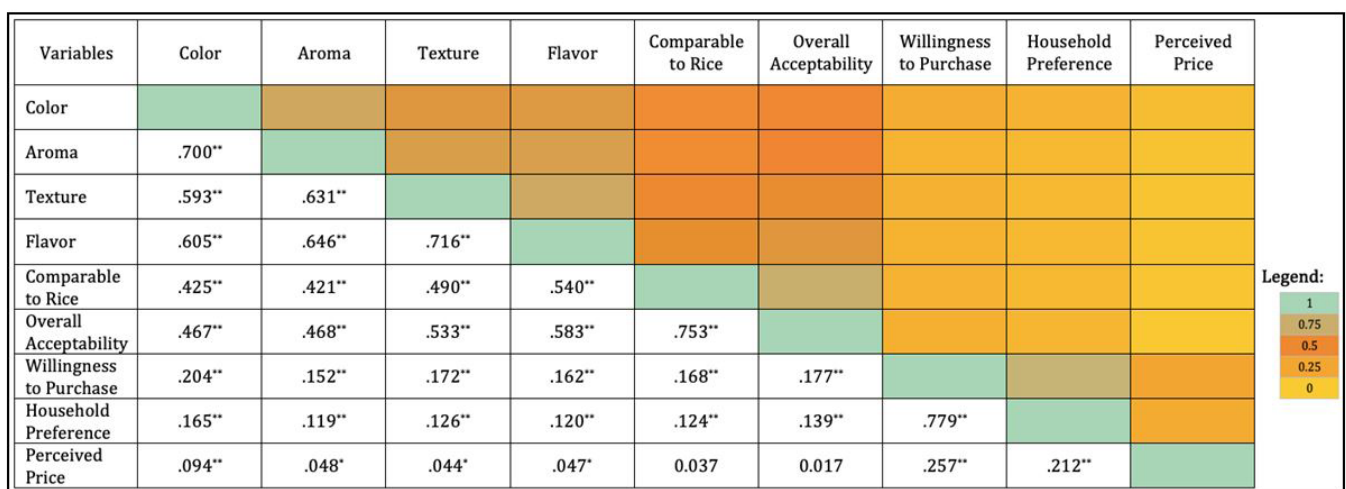
Variables	Color	Aroma	Texture	Flavor	Comparable to Rice	Overall Acceptability	Willingness to Purchase	Household Preference	Perceived Price
Color									
Aroma	.700**								
Texture	.593**	.631**							
Flavor	.605**	.646**	.716**						
Comparable to Rice	.425**	.421**	.490**	.540**					
Overall Acceptability	.467**	.468**	.533**	.583**	.753**				
Willingness to Purchase	.204**	.152**	.172**	.162**	.168**	.177**			
Household Preference	.165**	.119**	.126**	.120**	.124**	.139**	.779**		
Perceived Price	.094**	.048*	.044*	.047*	0.037	0.017	.257**	.212**	

Legend:
1
0.75
0.5
0.25
0

Figure 5. Correlation matrix heat map of consumer acceptability scores, willingness to purchase, household preference and perceived price (*significant at p<0.05; ** significant at p<0.01)

4. Conclusion

Cassava, a widely grown, carbohydrate-rich crop, was combined with corn, which is recognised to be the second most important crop in the country, to produce rice-like grains. In the consumer acceptability test, Binulak: IPB Var 6 ranked highest in aroma and flavour, while Lakan 2: IPB Var 13 ranked highest in terms of colour, texture, and overall acceptability. Characteristics shared among these products were its soft and glutinous texture, light yellow colour, bland taste, and the consistency of the shape of the grains. However, the majority's perceived price of the product regardless of the variety is less than €0.52, which was lower than that of rice. Significant correlations showed that there was a strong relationship between and among sensory attributes and overall acceptability of the product. Perceived price, among all the parameters, did not reflect a significant correlation with overall acceptability as well as its comparability to rice. While perceived price alone cannot be used as a basis for overall acceptability and marketability, household preference makes it more likely for mothers and caregivers to buy the product. The acceptability ratings, in terms of sensory attributes and perception, indicate that rice-like grains from cassava and corn are a viable alternative to rice. Other carbohydrate-rich crops, both widely grown and indigenous may be utilised to produce rice-like grains. Consumer acceptability among children under-five may also be explored to promote household food consumption and consequently address malnutrition.

Acknowledgement

Conflict of Interest

Authors declare no conflict of interest. The funding agency had no role in the design, collection, analysis, interpretation, and writing of the manuscript.

References

Aguilar, F.V. Jr. (2005). Rice in the Filipino Diet and Culture. Philippine Institute for Development Studies. Discussion paper series 2005-15. Retrieved from http://www.eaber.org/sites/default/files/documents/PIDS_Aguilar_2005.pdf

Ahenkora, K., Twumasi-Afryiyie, S., Sallah, P.Y., & Obeng-Antwi, K. (1999). Protein Nutritional Quality and Consumer Acceptability of Tropical Ghanian Quality Protein Maize. Food and Nutrition Bulletin, 20(3), 354-361.

Ali, D., Saha, K.K., Nguyen, P.H., Diressie, M.T., Ruel, M.T., Menon, P., & Rawat, R. (2013). Household Food Insecurity is Associated with Higher Child Undernutrition in Bangladesh, Ethiopia, and Vietnam, but the Effect is not Mediated by Child Diet Diversity. The Journal of Nutrition, 143(12), 2015-2021. DOI: 10.3945/jn.113.175182.

Catelo, S. P. (2004). Pacific Food System Outlook 2003-2004. Demographic Changes Affecting Food Demand, Spending Patterns and Nutrition in the Philippines. Retrieved from https://www.pecc.org/resources/foodagriculture-1/360-pacific-food-system-outlook-2003-2004-the-philippines/file

Champagne, E.T., Bett-Garber, K.L., Fitzgerald, M.A., Grimm, C.C., Lea, J., Ohtsubo, K., Jongdee, S., Xie, L., Bassinello, P.Z., Resurreccion, A., Ahmad, R., Habibi, F., & Reinke, R. (2010). Important Sensory Properties Differentiating Premium Rice Varieties. Rice, 3, 270–281. DOI: 10.1007/s12284-010-9057-4.

Custodio, M.C., Cuevas, R.P., Ynion, J., Laborte, A.G., Velasco, M.L., & Dermont, M. (2019). Rice Quality: How is it defined by consumers, industry, food scientists, and geneticists? Trends in Food Science and Technology, 92, 122-137. DOI: 10.1016/j.tifs.2019.07.039

De Leon, J.C. (2005). Rice that Filipinos Grow and Eat, Philippine Institute for Development Studies. Discussion paper series 2005-11. Retrieved from https://dirp4.pids.gov.ph/ris/dps/pidsdps0511.pdf

Escobar, M.M. (1992). Synthetic Rice Grains from Local Starches and Flours. MS Thesis-UPLB.

FAO (Food and Agriculture Organization of the United Nations). (1999). Poverty Alleviation and Food Security in Asia: Lessons and Challenges. Retrieved from http://www.fao.org/3/ab981e/ab981e00.htm#Contents

Francisco, S. R., Mataia, A. B., Eusebio, A.M., Sanguyo, E.B., Constantino, A.S., Causon, E. D., Quilloy, K., & Sombillia M. (2013). Per capita rice consumption in the Philippines: Reasons Behind Increases. Philippine Journal of Crop Science, 38(1), 33-42.

Hall, J. M. Shaw, Johnson, M. & Oppenheim, P. (1995). Influence of Children on Family Consumer Decision Making. In F. Hansen (Ed.) E-European Advances in Consumer Research Vol. 2 (pp. 45-53). Provo: Association for Consumer Research.

IRRI. (2016). Grain Quality: Breeding program management. Retrieved from http://www.knowledgebank. irri.org/ricebreedingcourse/Grain_quality.htm.

Juliano, B.O., del Rosario, R.R., del Rosario, O.M., & Roferos, L.T. (2004). Rice Quality: Kanin to Kakanin. In B.S. Vergara (Ed.) Philippine Rice Centennial: Research and Development (pp. 341-396). Muñoz: Philippine Rice Research Institute.

Lawless, H.T. & Heymann, H. (2003). Sensory Evaluation of Food: Principles and Practices. 2nd edition. New York: Springer.

Mamaril, V.R., Meneses, Z.L., Morales, E.D., Bautista, V.R., Panopio, J.O., & Matromonio, M.A. (2007). 2007 NSIC Approved Varieties. National Seed Industry Council, Bureau of Plant Industry, Department of Agriculture. Retrieved from https://nseedcouncil.bpinsicpvpo.com.ph/downloadables/catalogue2007.pdf

Mendoza, M.E.T., Arias, J.K.B., Ballaran Jr., V.G., & Burgos, B.M. (2014). From Vulnerability Assessment to Climate Change Adaptation: Lessons and Insights from the Philippine Component of the "Builiding Capacity to Adapt to Climate Change in Southeast Asia" Project. SEARCA. Retrieved from http://www.searca. org/phocadownload/report /Building-Capacity-to-Adapt-to-Climate-Change-in-Southeast-Asia.pdf

Meullenet, J.F., Griffin, V.K., Carson, K., Davis, G., Davis, S., Gross, J., Hankins, J.A., Sailer, E., Sitakalin, C., Suwansri, S., & Vasquez Caicedo, A.L. (2001). Rice External Preference Mapping for Asian Consumers Living in the United States. Journal of Sensory Studies, 16, 73-94. DOI: 10.1111/j.1745-459X.2001.tb00291.x

Meullenet, J.F., Marks, B.P., Hankins, J.A., Griffin, V.K., & Daniels, M.J. (2000). Sensory Quality of Cooked Long-Grain Rice as Affected by Rough Rice Moisture Content, Storage Temperature, and Storage Duration. Cereal Chemistry, 77(2), 259–263. DOI: 10.1094/CCHEM.2000.77.2.259

Mishra, A., Mishra, H. N., & Srinivasa Rao, P. (2012). Preparation of rice analogues using extrusion technology. International Journal of Food Science & Technology, 47(9), 1789–1797. DOI:10.1111/j.1365-2621.2012.03035.x

Motagnac, J.A., Davis, C.R., & Tanumihardjo, S.A. (2009). Nutritional Value of Cassava for Use as a Staple Food and Recent Advances for Improvement. Comprehensive Reviews in Food Science and Food Safety, 8, 181-194. DOI: 10.1111/j.1541-4337.2009.00077.x

Muthayya, S., Sugimoto, J.D., Montgomery, S., & Maberly, G. F. (2014). An overview of global rice production, supply, trade, and consumption. Annals of the New York Academy of Sciences, 1324, 7-14. DOI: 10.1111/nyas.12540

Noorgaard, M.K., Bruns, K., Christiansen, P.H., & Mikkelsen, M.R. (2007). Children's Influence on and Participation in the Family Decision Processing During Food Buying. Young Consumers, 8(3), 197-216. DOI: 10.1108/ 17473610710780945

Pandey, S., Sulser, T., Rosegrant, M.W., Bhandari, H. (2010). Rice Price Crisis: Causes, Impacts, and Solutions. Asian Journal of Agriculture and Development, 7(2), 1-15.

Peñaflor, L.M., Elepaño, A.R., & Peralta, E.K. (2014). Rice-Like Grains from Broken Rice (Oryza sativa L.) and Adlai (Coix lacryma-jobi L.). Asian Journal of Agriculture and Food Science, 2(4), 341-348.

Sales, Z.G., Juanico, C.B., Dizon, E.I., & Hurtada, W.A. (2018). Indigenous Pigmented Corn (Zea mays L.) Flour as Substitute for All-purpose Flour to Improve the Sensory Characteristics and Nutrient Content of Crackers. Malaysian Journal of Nutrition, 24(4), 617-625.

Somthawil, S. & Sriwattana, S. (2016). Comparing the sensory characteristics, physical properties, and consumer acceptability of purple rice cultivars. Food

and Applied Bioscience Journal, 4(2), 52–63. DOI: 10.14456/fabj.2016.6

Tibao, N.Y. (2009). Does the Philippines import rice: A solution to rice shortage. Retrieved from https://www.nodai.ac.jp/cip/iss/english/9th_iss/fullpaper/1-1-5nchu-tibao.pdf

Timmer, P. C. (2013). Food Security in Asia and the Pacific: The Rapidly Changing Role of Rice. Asia and the Pacific Policy Studies, 1(1), 73-90. doi: doi.org/10.1002/app5.6

UNICEF (United Nations Children's Fund). (2019). UNICEF: Many children and adolescents in the Philippines are not growing up healthily. Retrieved from https://www.unicef.org/philippines/press-releases/unicef-many-children-and-adolescents-philippines-are-not-growing-healthily

UPLB. (University of the Philippines Los Baños). (2018). Our Technologies Office of the Vice Chancellor for Research and Extension. Retrieved from https://ovcre.uplb.edu.ph/research/ourtechnologies/

Vaughn, C.J. (2000) The Price-Quality Relationship. Journal of Food Products Marketing, 6(1), 11-24, DOI: 10.1300/J038v06n01_02

Watts, B.M., Ylimaki, G.L., Jeffery, L.E. & Elias, L.G. (1989). Basic Sensory Methods for Food Evaluation. Ontario: International Development Research Centre.

Yongfeng, A. & Jay-lin, J. (2016). Macronutrients in Corn and Human Nutrition. Comprehensive Reviews in Food Science and Food Safety, 15, 581-599. DOI: 10.1111/1541-4337.12192