International Journal of Sustainable Agricultural Research
2025 Vol. 12, No. 2, pp. 109-119
ISSN(e): 2312-6477
ISSN(p): 2313-0393
DOI: 10.18488/ijsar.v12i2.4310

Hedonic price analysis for consumer preference on rice quality attributes in some selected state of North Western Nigeria

Bello Bunza Abubakar[1+]
Abubakar Ngaski ABDULLAH[2]
Muhammad Sani Muhammad JABO[3]

[1,2,3]*Department of Agricultural Economics, Usmanu Danfodiyo University, P.M.B. 2346, Sokoto, Nigeria.*
[1]*Email:* abubakar.bbunza@udusok.edu.ng
[2]*Email:* Abubakar.abdullahi@udusok.edu.ng
[3]*Email:* sani.jabo@udosok.du.ng

(+ Corresponding author)

Article History
Received: 8 April 2025
Revised: 17 June 2025
Accepted: 4 July 2025
Published: 21 July 2025

Keywords
Consumer demand
Domestic rice
Hedonic price
Imported rice
Market location
Rice brand
Rice types.

ABSTRACT

In Nigeria, rice consumption has significantly increased, particularly among urban populations. The country is the leading producer and consumer of rice in West Africa, with demand expected to rise due to population growth, urbanization, and changing dietary preferences. This study examined the influence of rice characteristics on pricing by analyzing 156 rice samples from 15 markets within a 400 km radius of the Middle Rima River Valley Irrigation Scheme. The hedonic price analysis of various rice types revealed that certain markets offered substantial price reductions, while consumers exhibited a willingness to pay a premium for imported rice. Although domestic rice possesses superior nutritional quality, characterized by higher amylose and protein content, consumers preferred imported rice due to its more appealing physical attributes. Key desirable qualities included a low percentage of broken grains, a high length-to-width ratio, minimal varietal mixing, and reduced impurities. To reduce the price disparity between domestic and imported rice, improvements in post-harvest handling and processing are crucial to enhance the physical characteristics of local varieties. Additionally, increased advocacy is necessary to emphasize the nutritional benefits of domestic rice and promote consumer preference for locally produced options.

Contribution/Originality: Efforts should be made to boost rice production in the Middle Rima Valley Irrigation Scheme, aiming to improve the physical attributes of domestic varieties and enhance postharvest handling, especially parboiling and milling operations, to reduce impurities and make domestic rice more attractive to consumers across Nigerian markets. There is also a need for farmers and authorities to promote domestic rice due to its nutritional benefits.

1. INTRODUCTION

Rice is a crucial food crop, serving as a staple and nutritious dietary component globally. It is consumed by over 4.8 billion individuals across 176 countries and holds particular significance as the primary food crop for more than 2.89 billion people in Asia, over 40 million in Africa, and over 150.3 million in America (FAOSTAT, 2018). In Nigeria, rice consumption is increasing, especially among urban populations. The nation is the leading producer and consumer of rice within the West African sub-region (Africa Rice Center (AfricaRice), 2018).

In Nigeria, rice constitutes a vital commodity, significantly contributing to the population's food requirements and is cultivated across nearly all agro-ecological zones of the country (Adeola, Adebayo, & Oyelere, 2008). However, recent data indicate that rice ranks as the third major cereal crop, following millet and maize, in terms of both output and cultivated land area (FAOSTAT, 2020). Globally, rice is the most critical food source for humans, with demand projected to reach 1,533 million tonnes by 2030, compared to 747.3 million tonnes in 2015 (Food and Agriculture Organization (FAO), 2018). It is currently the third most consumed cereal and the fourth most consumed crop in terms of caloric intake (Cadoni & Angelucci, 2013).

According to the Federal Ministry of Agriculture and Rural Development (FMARD) (2011), Nigeria is the second-largest importer of rice worldwide, spending over 356 billion Naira annually on rice imports. This heavy reliance on imports is largely due to the underperformance of the Nigerian agricultural sector (Federal Ministry of Agriculture and Rural Development (FMARD), 2011) particularly the perceived inferior quality of domestically grown rice remains a concern. Limited access to credit continues to be a significant barrier to the development of the rice value chain in Nigeria. Contract farming, through interlinked credit-output transactions (ICOT), has been demonstrated to enhance farmers' output, income, and poverty alleviation in developing economies (Chen & Chen, 2021; Key & Runsten, 1999; Shuaibu & Nchake, 2020).

Rice consumption is projected to increase by approximately 15% annually, driven by evolving consumer preferences (Chidiebere 2017). Consumers exhibit a high sensitivity to rice quality and are willing to pay premium prices for superior quality (Akoa Etoa et al., 2016). The observed price variations among rice samples of different quality classes suggest that grain quality attributes significantly influence rice pricing. However, preferences for quality attributes and their impact on consumer purchase prices are region-specific (Calingacion et al., 2014).

Grain physical characteristics, such as color, breakage rate, grain shape and length, chalkiness percentage, and purity, alongside chemical characteristics, including amylose and protein content percentages and gel consistency, which measures rice softness (Brorsen, Grant, & Rister, 1984; Cuevas, Pede, McKinley, Velarde, & Demont, 2016; Unnevehr, 1986) are anticipated to affect consumer decisions regarding rice pricing. This is grounded in the Lancaster (1966) Model of consumer behavior, which posits that products are consumed for their inherent characteristics, aligns with consumer preferences. The concept of hedonic pricing refers to the implicit prices of a commodity based on its characteristics or attributes. The term 'hedonic' is often associated with deriving satisfaction from the consumption of the good in question (Triplett, 2004). Selim (2009) noted that the hedonic pricing model theory is based on regression analysis, which may take the form of simple or multiple regression. Hedonic pricing models have been widely applied in the scientific community and have been utilized to measure utility based on the characteristics of goods in several studies of agricultural commodities, including rice (Abansi, Duff, Lantican, & Juliano, 1992; Anang, Zulkarnain, & Yusif, 2013; Bailey, Lawton, & Alvaro, 2020; Bonifacio & Duff, 1992; Gurung, Bhandari, Paris, & Mohanty, 2013; Hara, 2000; Kaosa-ard & Juliano, 1991; Kawamura, 1999; Untong, Pongpatcharatorntep, & Kaosa-ard, 2010) fruit juice (Weemaes & Riethmuller, 2001) and eggs (Kim, Lee, & Park, 2003). Bunyasiri and Prapinwadee (2018) examined consumer behavior and rice attributes, concluding that the core concept of hedonic price theory is based on product quality or attributes and the consumer's preference derived from product characteristics.

This study estimated the relationship between rice prices, location, and quality characteristics. The price paid by consumers represents an aggregation of the value attributed to both the quantity and quality of rice (Bunyasiri & Prapinwadee, 2018). In this study, only physico-chemical characteristics were considered. The findings indicate that consumers preferred rice with more appealing physical attributes, such as a low percentage of broken grains, a high length-to-width ratio, minimal varietal mix, and low impurity levels.

2. MATERIALS AND METHOD

2.1. Study Area

This study was conducted in the northwestern region of Nigeria, specifically in the states of Sokoto, Kebbi, and Zamfara. Sokoto State is situated between latitude 5° 13' 36.0012" E and longitude 12° 56' 14.7336" N, encompassing a land area of 27,825 km^2, with an estimated population of approximately 5,307,154 people as of 2016

(National Population Commission (NPC), 2006). Kebbi State is located between latitudes 10°08'N and 13°15'N and longitudes 3°30'E and 6°00'2"E, with an estimated population of about 4,724,046 people. Zamfara State lies between latitudes 12°10'12.86"N and longitudes 12°10'12.86"E, covering a land area of 37,931 km², with an estimated population of approximately 5,307,154 people (National Population Commission (NPC), 2006).

The region is characterized by the dry Sudano-Sahelian Savanna agro-ecological zone of Nigeria, receiving an average annual rainfall ranging from 300 mm to 700 mm, with distinct wet (May–October) and dry (November–April) seasons (NiMeT, 2019). Agriculture is the predominant occupation among the rural population. The primary food crops cultivated include rice, millet, maize, sorghum, cowpea, groundnut, and sesame, while tree crops such as mango and cashew are also grown in the area.

2.2. Rice Sample Collection

A total of 15 markets (5 urban and 10 rural) were randomly selected within a 400 km radius of Goronyo. Additionally, two markets were purposively selected in Nigeria's capital city: Abuja Market (urban) and Gosa Market (rural). A total of 156 samples were collected from these 15 markets for grain quality analysis (Table 1). During the collection of rice samples, respondents provided information regarding the type of rice traded (parboiled or white), trademarks (if any), origin of the sample (domestic or imported), price per unit of measure in Naira, and price per kilogram (in Naira). The milled rice samples obtained from the respondents were sent to the rice quality laboratory of AfricaRice in Ivory Coast for physicochemical analyses.

Table 1. Distribution of rice samples based on type and origin collected from markets within a 400km radius of the Marvis.

Qualitative variables	Market types	Frequency	Percentage
	Asera	7	5.072
	Bagega	8	5.797
	Bernin kebbi	10	7.246
	Gangara	8	5.797
	Godel	10	7.246
	Gorongo	8	5.797
	Gosa market	12	8.696
	Gusau	10	7.246
	Jega	10	7.246
	Kamba	9	6.522
	Kasuwan	8	5.797
	Mommon	5	3.623
	Sanyinna	10	7.246
	Sokoto	10	7.246
	Tilli	5	3.623
Market	Tureta	8	5.797
	White	17	12.319
Type of rice	Parboiled	121	87.681
	Domestic	98	71.014
Origin	Imported	40	28.986

2.3. Grain Quality Analysis

The grain quality parameters of both domestic and imported rice samples were evaluated for moisture content (%), as well as amylose and protein contents (%). The moisture content was determined using a Single Kernel Moisture Meter (PQ-510, Kett, Japan). The amylose and protein contents were assessed using Near Infrared Spectroscopy with the AN820 Instant Rice Composition Analyzer (KettUS, CA, USA). Impurities, defined as foreign materials such as weed seeds, stones, sand, heat-damaged grains, and husk, were manually sorted from 200g of each rice sample, weighed, and the percentage weight of the impurities was calculated.

Whole grains (head rice) were separated from broken grains using a laboratory rice grader (Satake, Hiroshima, Japan). Grain dimensions, mixed varieties, color damage, and chalkiness were determined as described by Ndindeng et al. (2015) using the S21 Rice Statistic Analyzer (LKL Technologia, Brazil). A color meter (CR-400, Minolta Co., Ltd., Tokyo, Japan) was employed to measure the color intensity of head rice based on the Lab uniform color space procedure (Zohoun et al., 2018).

A sample of 50g of whole grains was placed into the vibrator sample receiver following calibration with a chalky reference sample. The "long white" classification setup of the Classificador S21 software (Version 4.05) was verified in "capture" mode, and the vibrator was then activated to release individual grains from the receiver through an inclined blue tile beneath the camera, which captured images of the grains. The captured images were processed using the "advanced filter – length distribution" command to determine grain dimensions.

Average values of grain length and width, along with the calculated length/width ratio (LWR), were displayed and saved. The International Rice Research Institute (IRRI) classifies grain shape based on LWR as follows: round (LWR ≤ 1), bold (LWR 1.1–2.0), medium (LWR 2.1–3.0), and slender (LWR > 3.0). Mixed varieties were identified based on the percentage of grains with significant differences in width, while color damage was assessed as the percentage of grains with colored spots. To determine chalkiness, the basic filter–chalky distribution command was applied. The percentage of the total chalky area for the grains was recorded and reported as the percentage chalkiness of the samples. The IRRI classification of chalkiness is as follows: 1 (<10%), 5 (10–20%), and 9 (>20%) (Zohoun et al., 2018).

2.4. Statistical Analysis

2.4.1. Hedonic Price Model Specification

The hedonic price valuation approach has been widely used by economists in their studies (Boyle & Bishop, 1988; Bunyasiri & Prapinwadee, 2018; Earnhart, 2001; Kaosa-ard & Juliano, 1991; Kawamura, 1999). The Hedonic price model was drawn from the model of consumer demand developed by Ladd and Suvannunt (1976). According to Unnevehr (1986) and Bikram (2013) established that the consumer demand is based on consumer utility, which in turn is a function of product characteristics and is expressed as follows:

$$P_r = \sum_{j=1}^{n} \beta_{rj} x_{rj} \quad (1)$$

Where: P_r = The market price of the r sample of rice; X_{rj} = The number of characteristics j in the sample of rice; P_{rj} = The implicit value of characteristics j.

Adding a random error term to Equation 1 and an intercept to allow the effects of quality attributes, the completed estimation equation is expressed as follows.

$$P_r = \beta_0 \sum_{j=1}^{n} \beta_{rj} x_{rj} + u \quad (2)$$

Where: P_r = The market price of the rice sample of rice; β_{rj} = The amount of characteristics j in the r sample of rice; P = The implicit value of characteristics j; β_0 = Intercept term and u = Random error.

$$P_r = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + u \quad (3)$$

P_r = The market price of the rice sample of rice (₦/kg).

X_1 = Broken/head rice (%); X_2 = Length to width ratio; X_3 = Mixed variety (%); X_4 = Color damage (%); X_5 = Protein content (Dry matter) (%); X_6 = Moisture content (%); X_7 = Amylose content (%); X_8 = Chalkiness (%); X_9 = Impurities (%); X_{10} = Location (urban or rural); X_{11} = Rice type (white or parboiled); α = Constant term; u = Error term.

Mann–Whitney test was used to compare the grain quality traits between domestic and imported rice. The Mann–Whitney U test is a non-parametric test used in place of an unpaired t-test. It tests the null hypothesis that there is no significant difference between domestic and imported rice.

3. RESULT AND DISCUSSION

3.1. Distribution of Rice Samples Collected From

In the markets within the study area, the predominant rice type identified was parboiled rice, constituting 87.68% of the total (Table 1). Similarly, local or domestic rice accounted for a substantial proportion (71.01%) of the rice traded, while imported rice comprised 28.99% of the available rice in both rural and urban markets within the study area. This suggests that parboiled rice is more prevalent in the selected markets than white rice, potentially due to its superior cooking quality characteristics and higher head rice recovery during processing. Consistent with this finding, parboiled rice has been reported to be more abundant in Ghanaian markets compared to white rice. In contrast, Unnevehr (1986) reported a greater availability of white rice than parboiled rice in the Kandy market, Sri Lanka.

3.2. Characteristics of the Rice Samples

Characteristics of the rice samples: price and aggregate features, their extreme values, and the standard deviation of their mean values are listed in Table 2.

Table 2. Mean and variability of Price and grain quality characteristics of the rice samples.

Grain characteristics	Minimum	Maximum	Mean value	Standard deviation
rice (Naira/kg)	178.570	347.830	252.405	27.953
Broken (%)	0.160	40.490	8.531	8.370
Length to width ratio	2.289	3.828	2.974	0.376
Mixed variety (%)	0.780	49.780	14.089	13.708
Color damage (%)	2.900	97.120	64.173	25.278
Protein content (Dry matter) (%)	7.100	16.200	10.283	1.973
Moisture content (%)	9.900	12.150	11.141	0.524
Amylose content (%)	11.950	20.600	17.447	1.828
Impurities (%)	0.000	7.050	1.074	1.256

In this study, regardless of rice type, the mean price per kilogram of rice was N 252.405 (SD=27.953). The percentage of broken rice sold in the market ranged from 0.160% to 40.490% (SD=8.370), while the length-to-width ratio varied from 2.289 to 3.828 (SD=0.376). This aligns with the findings of Cuevas et al. (2016) and Bunyasiri and Prapinwadee (2018), who reported that consumers prefer rice with fewer broken grains. A higher mean value was recorded for color damage at 64.173% (SD=25.278), with a wide range between the minimum (2.9) and maximum values (97.12). This could be attributed to the higher variability in the color of domestic rice and the improper application of processing techniques. A high average protein content exceeding 10% was recorded for all samples, with a range of 7.1% to 16.2%. It can be inferred that the protein content of the rice samples traded in the markets within the study location is significantly above the average of 7% reported in several studies conducted in the Americas, Asia, and African continents (Julio & Villarea, 1993; Omari, Ampadu-Ameyaw, & Essegbey, 2018). The average percentage of impurities across all rice types was 1.07%, with some samples containing no impurities, while others had as much as 7%.

Hedonic price model for grain quality traits, market and type of rice and its origin.

Table 3. Impact of grain quality traits, market and type of rice and its origin in the study area.

Source	Price (Naira/kg)	Standard error
Intercept	244.360*	102.303
Broken (%)	-0.179	0.466
Length to width ratio	-1.433	16.347
Mixed variety (%)	-0.193	0.304
Color damage (%)	-0.156	0.142
Protein content (Dry matter) (%)	-0.210	1.939

Source	Price (Naira/kg)	Standard error
Moisture content (%)	4.263	7.218
Amylose content (%)	0.588	1.285
Impurities (%)	-2.227	2.234
Market-Asera	-2.994	8.052
Market-Bagega	-11.826	10.317
Market-Bernin Kebbi	1.643	10.451
Market-Gangara	-4.126	9.234
Market-Godel	-6.576	8.545
Market-Goronyo	-30.409**	9.244
Market-Gosa market	-27.448**	9.230
Market-Gusau	-2.330	8.131
Market-Jega	13.339	9.753
Market-Kamba	-20.410*	8.738
Market-Kasuwan	3.029	9.502
Market-Mommon	9.205	7.820
Market-Sanyinna	18.463	13.193
Market-Sokoto	-12.325	11.128
Market-Tilli	0.383	12.796
Type of rice	0.243	8.775
Origin	-30.263*	7.705
R^2 of model	56%	
P-value of model	<0.0001	

Note: Single and double asterisks (* and **) denote statistical significance at the 5% and 1% levels, respectively.

Rice is regularly consumed by individuals across all socio-economic classes (Lançon, Erenstein, Touré, & Akpokodje, 2004). However, preferences and willingness to pay a premium price for rice vary among different consumer categories, depending on factors such as urban residency and economic prosperity (Damardjati & Oka, 1992), and other determinants. The linear regression model for the hedonic price equation presented in Table 2 revealed that the model was significant at the 1% level, based on the P-value, and explained 56% of the variability observed in rice prices. The standardized rice price coefficients for the variables included in the model are presented in Figure 1.

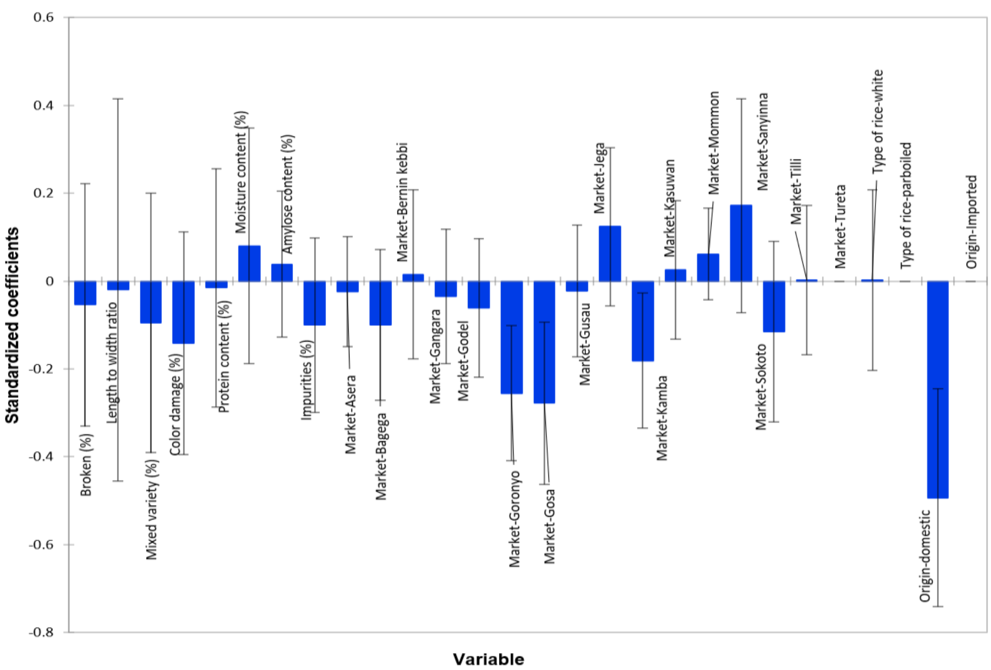

Figure 1. Standardize rice price coefficients for quantitative and qualitative variables in markets in and around Goronyo, Nigeria.

According to this model, grain quality traits and rice type did not significantly influence the price, potentially because chemical quality characteristics are credence attributes that consumers are unable to evaluate or verify independently (Rutsaert, Demont, & Verbeke, 2013). Nevertheless, even physical attributes such as head rice percentage, grain shape, and length do not appear to have a significant impact on price, as indicated by our findings. This may be attributed to the fact that the rice characteristics fell within the normal range and are typically classified under the same group. Sirisupluxana and Bunyasiri (2014) reported that Thai rice consumers prioritize physical quality, such as purity and the percentage of broken rice, over cooking quality.

The market exerted a significant discount effect on price in Goronyo (30.4 Naira per kg), Gosa (27.4 Naira per kg), and Kamba (20.4 Naira per kg) (Table 3). This may be due to the predominantly rural nature of these markets and the high supply of domestic rice. The highest price premium effect was observed in the Sanyinna market (a rural market), while the highest discount effect was recorded for domestic rice. Further analysis revealed that the price difference between Goronyo and Sanyinna, both rural markets (Figure 2), was not due to differences in grain qualities but rather to unobserved heterogeneity in these markets, possibly influenced by proximity to the rice irrigation scheme affecting supply. Therefore, enhancing grain quality traits of domestic rice to resemble imported brands could improve prices and reduce quality loss in domestic rice.

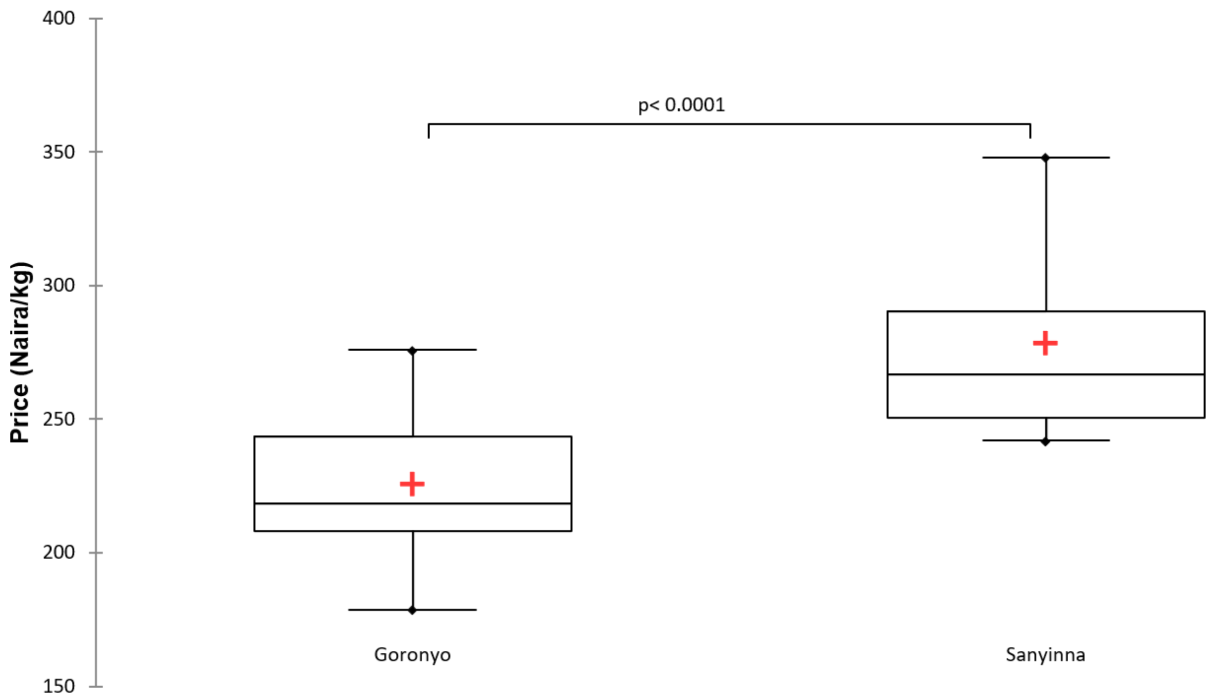

Figure 2. Comparison of rice prices between Goronyo and Sanyinna which are both rural markets in Sokoto state, Nigeria.

The origin of rice also demonstrated a significant inverse relationship with price, with domestic rice experiencing a significant discount effect (30.2 Naira per kg) compared to imported rice. This suggests that both urban and rural consumers preferred imported rice over domestic rice. A related study conducted in some provinces of the Benin Republic, a neighboring country to Nigeria, reported a similar preference for imported and parboiled rice over domestic and raw rice (Naseem, Mhlanga, Diagne, Adegbola, & Midingoyi, 2013). However, Naseem et al. (2013) concluded that the implicit prices paid by rice consumers in Benin for both domestic and imported rice were based solely on quality attributes, in stark contrast to the evidence in our current study. Furthermore, our results contrasted with the findings of Untong et al. (2010) who concluded that consumers place emphasis on the value of physical, cooking, and eating quality.

Table 4. Descriptive characteristics of domestic and imported rice collected in the study area.

Variable	Sample size	Minimum	Maximum	Mean value	Std. deviation	Mann -Whitney test (p-value)
Price (Naira/kg) domestic	98	178.570	347.830	242.322	24.063	P<0.0001
Price (Naira/kg) imported	40	235.290	333.330	277.108	20.574	
Percent broken domestic	98	0.520	40.490	11.061	8.300	P<0.0001
Percent broken imported	40	0.160	19.520	2.331	4.387	
Length to width ratio domestic	98	2.289	3.422	2.787	0.242	P<0.0001
Length to width ratio imported	40	2.440	3.828	3.431	0.218	
Mixed variety (%) S21 domestic	98	1.720	49.780	18.684	13.455	P<0.0001
Mixed variety (%) S21 imported	40	0.780	33.660	2.830	5.166	
Color damage (%) domestic	98	2.900	91.700	59.586	22.717	P<0.0001
Color damage (%) imported	40	6.980	97.120	75.413	27.904	
Chalkiness (%) domestic	98	0.000	50.040	2.469	7.425	P=0.492
Chalkiness (%) imported	40	0.000	16.510	1.405	3.906	
Color intensity domestic	98	7.404	12.429	9.804	1.052	P=0.606
Color intensity imported	40	7.654	14.382	10.078	1.489	
Protein (%) A820 domestic	98	8.450	16.200	11.064	1.768	P<0.0001
Protein (%) A820 imported	40	7.100	10.900	8.370	0.781	
Moisture (%) A820 domestic	98	9.900	12.150	10.976	0.508	P<0.0001
Moisture (%) A820 imported	40	11.000	12.100	11.545	0.297	
Amylose (%) A820 domestic	98	11.950	20.600	18.040	1.728	P<0.0001
Amylose (%) A820 imported	40	14.450	18.950	15.994	1.120	
Impurity (%) domestic	98	0.000	7.050	1.410	1.287	P<0.0001
Impurity (%) imported	40	0.000	2.900	0.251	0.669	

3.3. Grain Quality Traits between Domestic and Imported Rice

The grain quality traits between domestic and imported samples were further compared using the Mann-Whitney test. Significant differences were observed for all studied parameters except chalkiness and color intensity, and in most instances, imported samples recorded better values (Table 4). Consumers preferred rice with a low percent broken (2.3 ± 4.3%), high length to width ratio (3.4 ± 0.2), a low varietal purity (2.8 ± 5.1%) and low impurities (0.25 ± 0.6%).

Domestic rice recorded higher mean values for color damage at 59.586% (SD=22.713) and better protein content at 11.064% (SD=1.768) and amylose at 18.04% (SD=1.728). Since physical attributes such as grain shape, length, head rice percentage, and impurities are linked to premium prices and are more preferred, there is a need for improvement in some grain quality characteristics as well as the method of milling domestic rice so that it can resemble imported brands. Based on the length-to-width ratio of domestic samples at 2.787% (SD=0.242), they are classified as medium-grained, while the imported samples, with a ratio of 3.431% (SD=0.218), are considered slender in accordance with international standards (Cruz and Kush, 2000). Chalkiness of domestic samples was recorded at 2.469% (SD=7.425), while imported samples recorded 1.405% (SD=3.906); both domestic and imported samples fall within the same grade 1 (<10%) according recent classification (Zohoun et al., 2018). Interestingly, domestic rice is more nutritious, with high amylose (>18%) and protein (>11%) content, as well as lower moisture (10.9%) than imported rice.

This may not be unconnected to the prolonged storage and handling period that the imported rice might have suffered from, or the inherent genetic make-up of the domestic varieties. These imply that grain quality improvement will also increase the price of domestic rice to meet the price with imported rice. These findings corroborate the result of Calingacion et al. (2014), who reported that preferences for quality attributes and how they influence consumer purchase prices are region-specific.

4. CONCLUSION AND RECOMMENDATION

The results of this study indicate that only the location and origin of rice exert significant discounts in Goronyo, Kamba, and Gosa for price. Curiously, consumers were willing to pay a premium for better physical attributes of imported rice (shape, length, head rice percentage) over the nutritional superiority (lower moisture content and higher protein content) of domestic rice. Interestingly, amylose content (a surrogate feature of the eating quality of rice) also places domestic rice above the imported. The study, therefore, recommends that efforts to boost rice production in the Middle Rima Valley Irrigation Scheme should aim to improve the physical attributes of domestic rice varieties and also postharvest handling, especially parboiling operations and milling operations, to reduce impurities so as to make domestic rice attractive to consumers across Nigerian markets. There is also a need for farmers and authorities to promote domestic rice due to its nutritional prepotency.

Funding: This research is supported by Usmanu Danfodiyo University Sokoto (Grant number: 2021/R0-15).
Institutional Review Board Statement: The Ethical Committee of the Usmanu Danfodiyo University Sokoto, Nigeria, has granted approval for this study on 18 September 2021 (Ref. No UDUS/IDREC/2021/R0-15).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Abansi, C. L., Duff, B., Lantican, F. A., & Juliano, B. O. (1992). Consumer demand for rice grain quality in selected rural and urban markets in the Philippines. In: Consumer demand for rice grain quality. Edited by (Unnevehr, L. J., Duff, B. and Juliano, B. O.). In (pp. 37-57). Manila, Philippines: International Rice Research Institute.

Adeola, R., Adebayo, O., & Oyelere, G. (2008). Effects of the federal government special rice programme on rice yields and farmers' income in Oyo State. *International Journal of Agricultural Economics and Rural Development*, *1*(1), 1-6.

Africa Rice Center (AfricaRice). (2018). Annual report for 2016: Towards rice self-sufficiency in Africa. In (pp. 36). Abidjan, Côte d'Ivoire: Africa Rice Center.

Akoa Etoa, J. M., Ndindeng, S. A., Owusu, E. S., Woin, N., Bindzi, B., & Demont, M. (2016). Consumer valuation of an improved rice parboiling technology: Experimental evidence from Cameroon. *African Journal of Agricultural and Resource Economics*, *11*(1), 8-21.

Anang, B. T., Zulkarnain, Z. A., & Yusif, S. (2013). Production constraints and measures to enhance the competitiveness of the tomato industry in Wenchi Municipal District of Ghana. *American Journal of Experimental Agriculture*, *3*(4), 824-836.

Bailey, P., Lawton, L., & Alvaro, D. (2020). *Pricing open bagged rice in Nigeria: A hedonic price model approach.* Paper presented at the Agricultural & Applied Economics Association's 2020 AAEA Annual Meeting, Kansas City, Missouri, July 26-28th.Working Paper.

Bikram, G. (2013). A hedonic pricing model of rice for Bhutan. *International Journal of Humanities and Management Sciences*, *1*(2), 45-50.

Bonifacio, E., & Duff, B. (1992). The impact of postharvest operations on rough rice and milled rice quality in the Philippines. *Consumer demand for rice grain quality. International Rice Research Institute*, *933*, 149-157.

Boyle, K. J., & Bishop, R. C. (1988). Welfare measurements using contingent valuation: A comparison of techniques. *American Journal of Agricultural Economics*, *70*(1), 20-28.

Brorsen, B. W., Grant, W. R., & Rister, M. E. (1984). A hedonic price model for rough rice bid/acceptance markets. *American Journal of Agricultural Economics*, *66*(2), 156-163.

Bunyasiri, I. N., & Prapinwadee, S. (2018). Consumer's behavior and rice attributes for Thai HomMali Rice in Sichuan Province of China. *Journal of Business and Retail Management Research*, *12*(2), 242-252.

Cadoni, P., & Angelucci, F. (2013). *Analysis of incentives and disincentives for rice in Nigeria. Monitoring African Food and Agricultural Policies. Food and Agriculture Organization.* Retrieved from http://www.fao.org/mafap

Calingacion, M., Laborte, A., Nelson, A., Resurreccion, A., Concepcion, J. C., Daygon, V. D., . . . Bassinello, P. Z. (2014). Diversity of global rice markets and the science required for consumer-targeted rice breeding. *PloS One*, *9*(1), e85106.

Chen, J., & Chen, Y. J. (2021). The impact of contract farming on agricultural product supply in developing economies. *Production and Operations Management*, *30*(8), 2395-2419.

Chidiebere, M. (2017). *Analysis of value chain in rice production system in Ebonyi State, Nigeria.* A Thesis Submitted to the Post Graduate School Federal University of Technology, Owerri.

Cuevas, R. P., Pede, V. O., McKinley, J., Velarde, O., & Demont, M. (2016). Rice grain quality and consumer preferences: A case study of two rural towns in the Philippines. *PloS One*, *11*(3), e0150345.

Damardjati, D., & Oka, M. (1992). Evaluation of urban consumer preferences for rice quality characteristics in Indonesia. *Consumer Demand for Rice Grain Quality: Terminal Report of IDRC Projects, National Grain Quality (Asia), and International Grain Quality Economics (Asia). Manila, Philippines: International Rice Research Institute*, 59-73.

Earnhart, D. (2001). Combining revealed and stated preference methods to value environmental amenities at residential locations. *Land Economics*, *77*(1), 12-29.

FAOSTAT. (2018). *Food and agriculture organization statistical database. Food and Agriculture Organization of the United Nations.* Retrieved from http://www.fao.org/faostat/en/#home

FAOSTAT. (2020). *Food and agricultural organization statistical data base.* Retrieved from https://www.fao.org/faostat/en/#data. [Accessed 12th February, 2022]

Federal Ministry of Agriculture and Rural Development (FMARD). (2011). *Agricultural transformation agenda: We will grow Nigeria's agricultural sector.* Draft Report of the FMARD, Abuja, Nigeria.

Food and Agriculture Organization (FAO). (2018). *Sustainable rice based production and people's livelihood.* International Rice Commission Newsletter (Special Edition) 52, pp 24-36, Rome, Italy.

Gurung, K., Bhandari, H., Paris, T., & Mohanty, S. (2013). *Gender dynamics in changing rice-based agricultural systems in Bangladesh.* Policy Breifs, Los Banos, Laguna, Philippines: International Rice Research Institute (IRRI).

Hara, M. (2000). *Measuring positive externalities in Japanese rice production: A hedonic price analysis. Ecological Economics.* New York: Rensselaer Polytechnic Institute. DPhil.

Julio, P. G., & Villarea, A. T. (1993). Genetic diversity analysis of Cuban traditional rice (Oryza sativa L.) varieties based on microsatellite markers. *Genome*, *39*, 373-378.

Kaosa-ard, M., & Juliano, B. O. (1991). Assessing rice quality characteristics and prices in selected international markets. In Rice grain marketing and quality issues. In (pp. 23-25). Philippines: International Rice Research Institute.

Kawamura, T. (1999). *Hedonic price analysis and its application to package design: Packaged cooked rice in Japan.* Paper presented at the In Proceedings of the World Food and Agribusiness Congress. pp. 13-14.

Key, N., & Runsten, D. (1999). Contract farming, smallholders, and rural development in Latin America: The organization of agroprocessing firms and the scale of outgrower production. *World Development*, *27*(2), 381-401.

Kim, Y., Lee, H., & Park, J. (2003). Study on the consumption behavior of eggs in Korea. *Journal of Food Science*, *68*(4), 124-130.

Ladd, G. W., & Suvannunt, V. (1976). A model of consumer goods characteristics. *American Journal of Agricultural Economics*, *58*(3), 504-510.

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, *74*(2), 132-157.

Lançon, F., Erenstein, O., Touré, A., & Akpokodje, G. (2004). *Quality and competitiveness of local and imported rice on West African urban markets (No. REP-11507).* Mexico City, Mexico: CIMMYT.

Naseem, A., Mhlanga, S., Diagne, A., Adegbola, P. Y., & Midingoyi, G. S.-K. (2013). Economic analysis of consumer choices based on rice attributes in the food markets of West Africa—the case of Benin. *Food Security*, *5*, 575-589.

National Population Commission (NPC). (2006). *Population projection report for Goronyo and Gada Local Government Areas of Sokoto State, Nigeria.* Retrieved from https://www.nationalplanning.org/home-en/. [Accessed 10/11/2018]

Ndindeng, S. A., Manful, J., Futakuchi, K., Mapiemfu-Lamare, D., Akoa-Etoa, J. M., Tang, E. N., . . . Moreira, J. (2015). Upgrading the quality of Africa's rice: A novel artisanal parboiling technology for rice processors in sub-Saharan Africa. *Food Science & Nutrition, 3*(6), 557-568.

NiMeT. (2019). *Nigerian meteorological agency: Seasonal rainfall prediction*. Retrieved from https://www.nimet.gov.ng

Omari, R., Ampadu-Ameyaw, R., & Essegbey, G. (2018). *Marketing and promotional plan for local rice based on drivers of traders and consumers preferences*. Paper presented at the Forum for Agricultural Research in Africa (FARA).

Rutsaert, P., Demont, M., & Verbeke, W. (2013). 23 Consumer preferences for rice in Africa. In Realizing Africa's rice promise. In (pp. 294-302). Wallingford, UK: CABI.

Selim, H. (2009). Determinants of house prices in Turkey: Hedonic regression versus artificial neural network. *Expert Systems with Applications, 36*(2), 2843-2852.

Shuaibu, M., & Nchake, M. (2020). Credit market conditions and agricultural performance in Sub-Saharan Africa. *The Journal of Developing Areas, 54*(4), 41-53.

Sirisupluxana, P., & Bunyasiri, I. N. (2014). *Demand for Thai rice project (TDRI) (in Thai)*. Bangkok, Thailand: Thailand Development Research Institute (TDRI).

Triplett, J. (2004). Handbook on hedonic indexes and quality adjustments in price indexes: Special application to information technology products. In (pp. 1815-1965). Paris: OECD Publishing.

Unnevehr, L. J. (1986). Consumer demand for rice grain quality and returns to research for quality improvement in Southeast Asia. *American Journal of Agricultural Economics, 68*(3), 634-641.

Untong, A., Pongpatcharatorntep, D., & Kaosa-ard, M. (2010). Import demand for Thai rice and factors determining its price in modern trade market of China. *Journal of Applied Economics, 17*(2), 55–77.

Weemaes, H., & Riethmuller, P. (2001). *What Australian consumers like about fruit juice: Results from a hedonic analysis*. Paper presented at the World Food and Agribusiness Symposium, International Food and Agribusiness Management Association, Sydney 27-28 June 2001.

Zohoun, E. V., Ndindeng, S. A., Soumanou, M. M., Tang, E. N., Bigoga, J., Manful, J., . . . Futakuchi, K. (2018). Appropriate parboiling steaming time at atmospheric pressure and variety to produce rice with weak digestive properties. *Food Science & Nutrition, 6*(4), 757-764.