

Consumer Preferences for Quality Characteristics Along the Cowpea Value Chain in Nigeria, Ghana, and Mali

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ABSTRACT

The production and trade of cowpea is a growing business in West Africa. But a better understanding of consumer preferences is essential to market development. The objective of the study was to determine the impact of cowpea grain quality characteristics on market price. The data for the study were collected from markets in Nigeria, Ghana, and Mali. Hedonic pricing methods provide a statistical estimate of premiums and discounts. The results indicated that cowpea consumers in Ghana, Mali, and Nigeria are willing to pay a premium for large cowpea grains. Bruchid damage is not statistically significant in any market. The impact of price on other cowpea quality characteristics such as skin color and texture and eye color vary locally. Implications for development of the cowpea value chain are as follows: (a) researchers should identify cost-effective ways to increase cowpea grain size because larger grain are preferred and (b) serving local markets requires a portfolio of grain skin and eye color and skin texture combinations. [EconLit citations: Q130]. © 2009 Wiley Periodicals, Inc.

1. INTRODUCTION

Cowpeas (*Vigna unguiculata*), also known as black-eyed peas in the United States, are the most important indigenous grain legume in West and Central Africa. They are grown by small-scale farmers throughout the region and because cowpeas are naturally drought tolerant, they are extremely important in semiarid areas. Cowpeas are important to small-scale farmers because they are a cash crop and provide high protein food for family consumption. The rapidly expanding urban populations of West Africa create an opportunity for cowpea producers and merchants. Farmers and merchants in traditional markets usually have a good sense for the preferences of their immediate customers, but a regional understanding of consumer preferences is needed to support expanded trade. In particular, researchers developing higher yield cowpea production systems and nongovernmental organizations (NGOs) doing technology transfer lack information on these cowpea preferences. The objective of this study is to measure the preferences of urban cowpea consumers in selected West African cities. Cowpea samples were purchased monthly over a multiyear period. Premiums and discounts for grain size, damage levels, and other characteristics were estimated using hedonic pricing techniques. The study provides essential information for everyone involved in developing the cowpea value chain in West Africa, from cowpea breeders to national extension staff and policy makers.

In West Africa, cowpea grain passes through a well-established value chain with regional trade flowing mainly from the semiarid production areas in the Sahel to the more urbanized coastal zones (Langyintuo et al., 2003). The international research and development community has recognized the importance of cowpea to the development of West and Central Africa. The Bean Cowpea Collaborative Research and Support (CRSP) program funded by the United States Agency for International Development (USAID) has conducted research on production, marketing, and utilization of cowpea in West Africa for over 20 years. The cowpea marketing team of the Bean/Cowpea CRSP has good linkages with local and international organizations with cowpea market research program including International Institute of Tropical Agriculture (IITA) and its Cowpea Project for Africa (PRONAF). The importance of understanding markets and market chains has been recognized by national agricultural research systems and by NGOs throughout West Africa, including World Vision (www.wvi.org), the National Agricultural Research Institute of Niger (INRAN), the Rural Economics Institute (IER) of Mali, and the Institute for Agricultural and Environmental Studies (INERA) of Burkina Faso.

This article is outlined as follows. The West Africa and the Importance of Cowpeas section highlights key characteristics of the study region. The role of cowpeas in the economy and particularly with respect to development is also described. The Value Cowpea Chain section describes the cowpea value chain and highlights previous research that has provided insight on the operations and effectiveness of cowpea markets. The Motivation for the Research section presents the motivation for the research and states specific hypotheses. The Methodology section is next, followed by the Results and Discussion section, which reports the results of the study. Next, the implications of the results are discussed, followed by the Conclusions section.

2. WEST AFRICA AND THE IMPORTANCE OF COWPEAS

In West and Central Africa, cowpeas are big business. In the 1990s, about 2.6 million tons of cowpea were produced on 7.8 million hectares annually (Langyintuo et al., 2003). Depending on the location, year, and time of year, the retail price of cowpea varies from about US\$200/ton to over US\$1000/ton. At a conservative value of US\$500/ton, the retail value of cowpea in West and Central Africa is US\$1.3 billion per year. Cowpea production in West and Central Africa represents almost 70% of world production of cowpea and about 80% of world cowpea production area. Official sources record a regional cowpea grain trade of almost 300,000 metric tons annually in the late 1990s. The unofficial trade is probably much larger. The largest cowpea exporting country in the region (and in the world) is Niger. Nigeria is the largest cowpea producer in the world with an annual production of almost 1.7 million metric tons in the 1990s. With about 25% of the population of Sub-Saharan Africa, Nigeria is also the largest importer of cowpea in the region.

Cowpea production is concentrated in the drier areas of West and Central Africa (Figure 1). The northern limit of production is approximately the 300 mm rainfall isohyte almost the Sahara Desert. In general, cowpea trade flows from the drier inland areas to the more humid and densely populated coastal areas. The largest cowpea market in the world is Dawanau market in Kano in northern Nigeria. Cowpea storage capacity in Dawanau market exceeds 200,000 metric tons. Merchants from the Dawanau market finance a network of cowpea buyers throughout Niger and the neighboring countries. Merchants from southern Nigerian cities come to Kano to purchase cowpea. A similar pattern occurs at a smaller scale in other coastal countries.

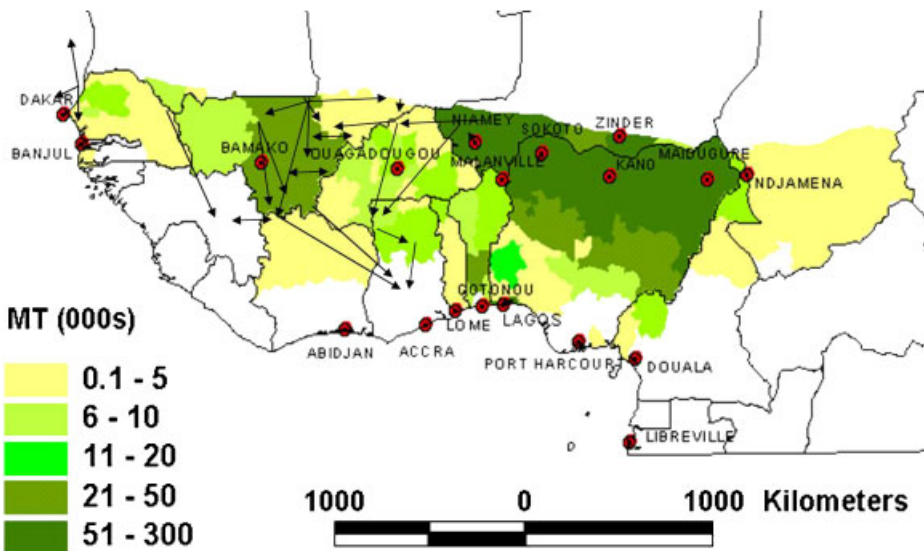


Figure 1 Cowpea production and distribution in West and Central Africa. Note. Arrows indicate the major movement of cowpea grain trade. Source: Langyintuo et al., 2003.

Although cowpea grain is two or three times as expensive as maize, rice, or other cereals, it is relatively cheap compared to other protein sources (e.g., milk, meat, eggs). Because cowpea grain can be stored, it is an important protein source for poor people who do not have access to refrigeration. Cowpea is often called the “poor man’s meat.” Cowpeas are used both for food preparation at home and for production of street foods. At home, cowpeas are often added to sauces and stews. Cowpea fritters, called “kosai” in some inland areas and “akara” in many coastal countries, are one of the most common street foods. Informal observation suggests that the income elasticity of cowpea consumption in West Africa is positive and relatively high. In West and Central Africa, when the incomes of poor people grow, they often increase cowpea consumption.

Although the countries of West Africa are poor by any standard, their markets are growing (Table 1). Population growth averages between 2% and 3% per year and population is increasingly urban, by 3% to 5% annually. Incomes are low: Gross domestic product (GDP) per capita is in the \$200 to \$400 range for the inland countries and in the \$200 to \$900 range for coastal countries. Some markets, however, have seen remarkable growth. For example, cell phone use has spread rapidly in the region from almost nothing a decade ago to over 10% of the population in some countries (Table 1). For some countries, rising prices for energy (i.e., oil in Nigeria, Cameroon, and Tchad and uranium in Niger) provide an economic engine for increased demand. In other countries, agricultural product exports (e.g., cocoa, cotton) provide the impetus toward economic growth. Selling to consumers in West Africa is an opportunity for the local and international entrepreneurs who understand their preferences and develop ways to serve them.

TABLE 1. Market Potential Indicators for West and Central African Countries, 2004

	GDP per capita \$US	Population in millions	Pop. growth rate (%)	Percent urban population (%)	Cell phones per 1000
Benin	498	8.2	2.73	39.7	NA
Burkina Faso	376	12.8	3.00	17.9	31
Cameroon	897	16.0	2.04	53.7	96
Cote D’Ivoire	866	17.9	2.03	44.6	86
Gambia	281	1.5	2.84	53.0	118
Ghana	409	21.7	2.07	47.1	78
Guinea	421	9.2	2.63	32.6	NA
Guinea Bissau	182	1.5	2.07	29.6	NA
Mali	371	13.1	2.63	29.9	30
Mauritania	515	3.0	2.88	40.3	175
Niger	228	13.5	2.92	16.7	11
Nigeria	560	128.7	2.38	47.3	71
Senegal	683	11.4	2.34	41.3	90
Sierra Leone	202	5.3	2.30	39.9	22
Tchad	447	9.4	2.80	24.8	13
Togo	344	6.0	2.72	39.4	NA

Source: United Nations, Human Development Report (2006).

NA = not available.

3. THE COWPEA VALUE CHAIN

Cowpeas are consumed regularly in virtually every household in West Africa. Although some cowpeas are purchased as green pods at harvest time and, in some regions, the leaves are eaten as greens, the majority of cowpeas are sold as grain in bulk form. Vendors display large bowls of cowpea that consumers can inspect before making their purchase. There are a number of visual characteristics of the cowpeas that have been shown, at least anecdotally, to be preferred by consumers. For example, the main varieties available on the open markets in West Africa are white-skinned grains with a black eye (Lambot, 2000); however, in some areas, red- or black-speckled cowpeas are preferred.

Cowpeas vary according to the size of the grain, color of the skin, texture of the skin, color of the eye, and the amount of damage resulting from insects. The size of the grain is commonly measured by breeders by weighing 100 randomly selected grains. The color of cowpeas (often referred to as skin or testa color) vary and can be white, black, brown, or red. The cowpea skin can be a uniform in color or speckled. The skin or outer coating of the cowpea can be rough or smooth. The color of the eye of the cowpea can be black, grey, or brown. It is important to note that although the cowpea grain can be stored for use throughout the year, a major disadvantage is that it is prone to insect damage. In particular, cowpea weevils (called bruchids) infest the cowpeas and eat holes in the grain. It is generally understood that consumers prefer cowpeas with less insect damage. Effective chemical and nonchemical storage methods are available, but West and Central African producers and merchants do not always use them (Murdock, Seck, Ntoukam, Kitch, & Shade, 2003).

The cowpea value chain comprises traders and markets that ensure a movement of grain from rural markets to urban wholesale markets and finally to consumer markets. The cowpea value chain begins with the production of cowpeas by small-scale farmers throughout West Africa as shown in Figure 2. In the Sahelian countries of Niger, Burkina Faso, and Mali and in the inland areas of coastal countries,

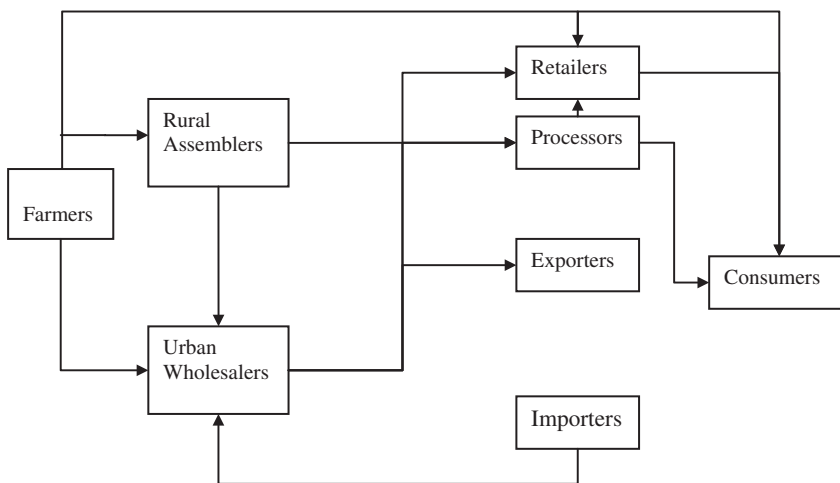


Figure 2 The typical within country cowpea value chain in West and Central Africa.

farmers typically sell their marketable surplus grains to rural assemblers, who, in turn, sell to urban wholesalers directly or through commission agents (Langyintuo et al., 2003). Exports and imports of cowpea among the countries in West and Central Africa is substantial, with official sources recording regional cowpea grain trade of almost 300,000 metric tons annually in the late 1990s. Commission agents sell grain on behalf of their clients (rural assemblers) and provide storage, but they do not take any price risk associated with the storage function. Usually the commission fee paid by rural assemblers to the commission agent varies from country to country. The commission fee is often about 2% of the wholesale price depending on the country in question (Langyintuo et al., 2003).

In Nigeria, Ghana, Togo, Benin, and Burkina Faso, grain traders have organized themselves into commodity-based associations to promote marketing of grain and to put in place the guidelines for grain pricing (Langyintuo et al., 2003). These associations provide a bridge between grain traders and government organizations.

Faye, Jooste, Lowenberg-DeBoer, and Fulton (2006) report on a hedonic pricing analysis of data from six markets in Senegal. Larger grain size was statistically significant and positive at all markets, but the premium varied from 1% of average price in the Castors market in Dakar for a one gram increase to 16% in the Mpal market in northern Senegal. Thebruchid damage coefficient is negative and statistically significant only for the Tilene market in Dakar. Preference for cowpea color, eye color, and skin texture varied from market to market.

Langyintuo, Ntougam, Murdock, Lowenberg-DeBoer, and Miller (2004) reported that consumers in the markets in Cameroon and Northern Ghana generally prefer large undamaged cowpeas grain. However, there was an exceptional case in the Mokolo, Cameroon, and Wa, northern Ghana markets where consumers prefer small-seeded, traditional grains presumably because of the taste. In both countries, eye color was noted to be an important grain quality characteristic for which consumers are willing to pay a premium. In Ghanaian markets (North Ghana), consumers prefer cowpeas with black eyes.

In Cameroon, northern Ghana, northern Nigeria, and Senegal, cowpea consumers place value on large cowpeas and dislike damaged grains (Langyintuo et al., 2003, 2004). Further, in northern Ghana, consumers prefer cowpeas with black eyes. However, cowpea consumers in northern Cameroon discount cowpeas with black eyes. Langyintuo et al. (2004) also reported that consumers in northern Ghana pay a premium for white cowpeas.

As described above, market participants engage in moving, storing, grading, and processing cowpeas in expectation that this will augment their value to consumers, because they will be able to supply or serve the market segments with needed produce at a particular time of the year. In West Africa, almost all cowpea production occurs between October and December, while consumption occurs throughout the year. The variation of cowpea prices are typical of a commodity where production occurs at one point in time and the product is stored for use throughout the year. Typically, prices are lowest during harvest. Prices rise steadily thereafter to a peak in the June, July, and August period.

In addition to consumer preferences, there are also other factors that influence cowpeas consumption in West Africa. Kormawa, Chiunu, and Munyong (2000) reported that the level of cowpea consumption in Nigeria is determined by the following four major factors: income level of consumers, taste of the product, market

price of cowpea and of its close substitutes, and population density of towns. Further, Kormawa et al. reported that cowpea prices are lowest in December (harvesting season) in the Abuja, Kaduna, Kano, and Ibadan markets. In addition, Kormawa et al. reported that consumers in the Nigerian markets they studied generally preferred brown-colored over white-colored cowpeas.

4. MOTIVATION FOR THE RESEARCH

A better understanding of consumer preferences for cowpeas is needed to understand the cowpea value chain and facilitate cowpea market development in West and Central Africa. Studies have shown that consumers are the beginning of the value chain whereby the flow of information about food preference moves back to retailers, manufacturers, farmers, and scientific laboratories (Kinsey, 2001). Likewise, Boehlje (1999) accentuated the importance of information in the value chains. He elucidates the fact that customer information is the resource that can be used to understand markets better.

Although consumer preferences in some cowpea markets near production areas have been studied (Faye et al., 2006; Langyintuo et al., 2004), consumer preferences in the rapidly growing urban markets are almost undocumented. Most farmers and merchants intuitively understand the preferences of their immediate customers, but they lack information on the preferences of new clientele in distant cities. Researchers, extension staff, and NGO personnel need a way to identify the cowpea traits on which they should focus. Hedonic pricing methods provide a systematic, formal mechanism for estimating the strength of cowpea preferences.

As noted above, the general objective of this study is to measure the premiums and discounts negotiated by consumers for various visual characteristics of cowpea grain. This objective is achieved by testing the hypotheses that cowpea consumers in urban markets in Nigeria, southern Ghana, and Mali are willing to

- pay a premium for larger sized cowpeas,
- pay a premium for white cowpeas,
- discount damaged cowpeas that result from bruchid holes,
- pay a premium for cowpeas with rough skin, and
- pay a premium for cowpeas with black eyes.

5. METHODOLOGY

Retail-level cowpea samples were purchased monthly in three markets in Nigeria, two markets in Mali, and six markets in southern Ghana. In Nigeria, the markets studied were Iddo (Lagos), Monday (Maiduguri), and Dawanau (Kano). Lagos is the largest city in Nigeria and represents important urban consumers, while the Dawanau market in Kano is the largest wholesale cowpea market in the world. Truckloads of cowpeas come from all over West Africa to the Dawanau market, which also has a substantial retail clientele. The Maiduguri market is located in northeast Nigeria, close to the Niger and Cameroon borders. In Bamako, the capital city of Mali, samples were purchased in Marché de Médine and Marché de Sabalibougou. Marché de Médine, located in northeast part of downtown Bamako, is a mixed market where both wholesalers and small-scale retailers operate. Marché

de Sabalibougou is a retail market in a suburb of Bamako. Cowpeas sold in the market come in directly from production areas, as well as through resellers from the main markets in town. Markets studied in Ghana include the Makola, Kaneshie, Malata, and Nima markets in Accra and the Central and Asafo markets in Kumasi. The Makola market, the central and major market of Accra, sells all types of consumer goods (foodstuff, provisions, clothing, etc), largely at the retail level. Female traders are major actors in retail trade in the Makola market. Although smaller than the Makalo market, the Kaneshie market is a modern market with relatively better facilities. Generally speaking, Kaneshie is the retail market, and female traders dominate the cowpea trade. The Malata market started largely as a foodstuff market but has developed to include other products. Wholesale trade of foodstuffs is also a part of the trade in Malata. Although both males and females are involved in wholesale trade, female traders are mainly involved in retail business. The Nima market is a small market that largely serves people of the northern Ghana origin who reside in Nima. The importance of cowpeas in this market is the result of the importance of this crop in the diet of the people of Nima (northern Ghanaians). The Central market is the major market serving Kumasi where all types of consumer goods are sold, both wholesale and retail, and are carried out by both males and females (although females dominate the retail trade.) The Asafo market is a smaller market and less patronized compared to the Central market. Although the Asafo market is less than 2 km (≈ 1.243 miles) from the Central market, the prices in Asafo market are perceived by consumers to be higher than in the Central market. The cowpea trade in the Asafo market is mainly a retail trade in which female traders dominate.

Hedonic price estimation techniques have been applied to a wide range of economic issues, ranging from determining optimal production mix to marketing issues (Brosen, Grant, & Rister, 1984; Espinosa & Goodwin, 1991; Kawamura, 1999; Parker & Zilberman, 1993; Unnevehr, 1986; Walburger & Foster, 1994). In this study, hedonic analysis is used to analyze the consumer preferences for cowpea quality characteristics. A good way of understanding the hedonic analysis framework is to view each good in terms of the set of characteristics it possesses (Ladd & Suvannut, 1976). For any given good, say, cowpeas, let the set of characteristics be ordered and denoted by $(x = x_1, \dots, x_k)$. It is then assumed that the preference of consumers in the market for a particular good is solely determined by its corresponding characteristics vector. In addition, it is assumed that there is a functional relationship between the good's price, p , and its characteristic vector x in the form of equation $p = f(x)$. This functional relationship specifies the hedonic relationship or hedonic regression typical for the good in the market (Hans, 2003).

Empirical estimation, using hedonic price analysis, then takes the form of

$$P_C = \sum_{j=1}^m X_{Cj} \beta_{Cj} + \epsilon \quad (1)$$

where P_C is the price of cowpea and ϵ is random error. The dependent variable P_C will vary for the different cowpea characteristics. The independent variables, the X_{Cj} , should explain variance in the cowpea price and the parameter estimates (β_{Cj} 's) gives the implicit values of grain characteristics.

From the general function, the regression model that was estimated for this research was of the following form:

$$P_{it} = \alpha_{io} + \sum \gamma_{ir} Y_{irt} + \sum \Psi_{ik} M_{ikt} + \sum \beta_{ij} X_{ijt} + \epsilon_{it} \quad (2)$$

where P_{it} is the price of cowpea in US\$ (equivalents of local currencies in which they were collected) per kilogram at market i ($i = 1, 2, 3, \dots, N$) at time t ($t = 1, 2, \dots, T$). Y_{irt} is Yearly dummy ($r = 1, 2, \dots, N$), and M_{ikt} is monthly dummy ($k = 1, 2, \dots, 11$) to account for the effect of time in price variability. X_{ijt} referred to the cowpeas' characteristics ($j = 1, 2, \dots, J$), size of the cowpea grains (weight of 100 grains), grain damaged by bruchids, skin texture, skin color, and eye color. α is constant term, β , Ψ , and γ are parameters estimated and ϵ is a stochastic error term. Separate equations were estimated for each of the markets with seemingly unrelated regression (SUR) because of correlation between prices at different markets in the same country (Zellner, 1962).

The price variable is reported as market price per kilogram. The monthly dummy variables are important to account for the seasonal variation in cowpea prices, noted above, and the month of November was used as the reference month in all the markets. The yearly dummy variables account for the different market conditions in each market year. Notice that seasonal years were used for the year dummies. The seasonal year was considered to start from October to September of the following year. For Ghana and Mali, seasonal year 2000 was used as a reference seasonal year, while for Nigeria year 1999 was used as the reference seasonal year. The number of holes per 100 grains was entered in the model as an absolute value. Grain eye color, grain skin color, and skin texture were entered as dummy variables. The approach to create dummies for skin color was to assign a value of one for the white-colored grains and zero otherwise. A value of one was assigned to black eye color and zero otherwise. A value of one was assigned for rough skin texture and zero otherwise.

This analysis uses samples from a multiyear period in each location. Nigeria data were collected between October 1998 and October 2001. Southern Ghana data were collected from May 2000 to April 2002, and the Mali data were collected from October 1999 to December 2001. The sample selection and data collection procedure followed a common protocol in all three counties. Samples were purchased each month on a predetermined day (e.g., third Thursday) and a common time (between 10:00 a.m. and noon). A common protocol to ensure a random selection of five vendors was utilized in all of the markets. A researcher or technician purchased cowpeas from each of the five vendors using the common local unit of measurement (often called a tin). The buyer was instructed to bargain just as he or she would in making any purchase in a traditional African market. The five samples of cowpea were taken to the laboratory where data on 100 grain weight, number of bruchid holes, skin color, skin texture, eye color, and other characteristics were recorded.

To make the result of this study more robust, the model transformation procedure was employed to compare the model functional forms and decide on the more appropriate model for this study. The Box and Cox transformation analysis was used, which is basically a modified power transformation (Sakia, 1992). For generalizing linear model, the Box-Cox transformation is of the following form:

$$x^{(\lambda)} = \frac{x^\lambda - 1}{\lambda} \quad (3)$$

In the linear model, the analysis can be done conditionally. For a given value of λ , the model is as follows:

$$y = \alpha + \sum_{k=1}^k \beta_k X_k^{(\lambda)} + \epsilon \tag{4}$$

Often, the least square values of λ is between -2 and 2 (Greene, 2003).

The Box-Cox model can be extended to applications in which both the dependent and the set of independent variables are transformed in the same way (SHAZAM, 1997). The functional form for the same transformation is written as

$$Y^{(\lambda)} = X^{(\lambda)}\beta + \epsilon \tag{5}$$

which means the same value of lambda transforms all the variables in the model.

6. RESULTS AND DISCUSSION

Comparison is made among the cowpea markets in the three countries of Nigeria, Southern Ghana, and Mali. To facilitate cross country comparisons, local currencies were converted to \$US (1 US\$ = 107.4 Naira[Nigeria]; 6725.5 Cedi[Ghana]; 732.17 FCFA[Mali]) at the average exchange rate for the period May 2000 to Oct. 2001 (IFS, 2006). The results show that the cowpea prices were lower in the Mali and Nigerian markets relative to the southern Ghana markets (Table 2). The average cowpea prices were as follows: \$0.39 per kg in the Malian markets, \$0.54 per kg across the six southern Ghana markets, and \$0.36 per kg across the three Nigerian markets. On average, cowpea prices were higher in the Accra markets than in the Kumasi markets (Table 2). The variation of prices between Accra and Kumasi markets could be due to geographical location and levels of economic activities of

TABLE 2. Average Cowpea Grain Characteristics

Country/data	Market	Prices (\$kg ⁻¹) ¹	Holes/100 grains	100 grain weight (g)
Southern Ghana	Makola (Accra)	0.59 (0.17)	13 (22)	14.4 (4.6)
	Kaneshie (Accra)	0.60 (0.17)	11 (15)	14.9 (4.4)
	Malata (Accra)	0.57 (0.17)	16 (26)	14.3 (4.0)
	Nima (Accra)	0.59 (0.17)	10 (13)	14.6 (4.2)
	Central (Kumasi)	0.42 (0.09)	12 (16)	13.6 (3.0)
	Asafo (Kumasi)	0.46 (0.09)	12 (16)	14.4 (3.7)
	All Markets	0.54 (0.14)	12 (18)	14.4 (4.0)
Mali	Marché de Sabalibougou	0.38 (0.11)	15 (12)	11.8 (3.1)
	Marché de Médine	0.39 (0.13)	14 (12)	12.1 (3.4)
	All Markets	0.39 (0.12)	14 (12)	12.0 (3.2)
Nigeria	Iddo (Lagos)	0.43 (0.13)	9 (6)	18.7 (3.8)
	Monday (Maiduguri)	0.29 (0.09)	5 (5)	18.5 (4.6)
	Dawanau (Kano)	0.37 (0.08)	7 (5)	18.4 (3.4)
	All Markets	0.36 (0.10)	7 (6)	18.5 (3.9)

Note: Standard deviation in parentheses. Exchange rates used were the average exchange rate (in US\$) between May 2000 and October 2001. Nigeria, southern Ghana and Mali studies (Jamal, 2005; Mishili, 2005; Shehu, 2003).

these cities. Accra being the capital and also a coastal city has more economic activities and higher population density compared to Kumasi. Although the per kilogram price of cowpea was higher in the Accra markets than the Kumasi markets, the standard deviation of price was lower in Kumasi markets. This suggests price stability in the markets in Kumasi compared to the markets in Accra.

On average, the cowpea markets surveyed in Mali had more damaged grains than the southern Ghana and Nigerian markets (Table 2). *Marché de Sabalibougou* had an average of 15 holes per every 100 grains, which was slightly higher than *Marché de Médine*. In southern Ghana, the average grain damage was 12 holes per 100 grains. Notice that the Makola and Malata markets in Accra had the highest levels of damage in Southern Ghana. This could be due to the fact that Accra is a coastal city with higher humidity levels, which can affect grain damage level. Damage levels in the Nigerian markets averaged 7 holes per 100 grains.

It was observed that cowpeas in the Nigerian markets were, on average, larger than cowpeas in the southern Ghana and Malian markets (Table 2). On average, the weight of 100 grains was 18.5 g in the Nigerian markets and 14.4 g and 12.0 g in the southern Ghana and Malian markets, respectively. From Table 2, notice that the size of the grains in the southern Ghana, Mali, and Nigerian markets are consistent, as evidenced by the low standard deviation.

The seemingly unrelated regression analysis results are reported in Tables 3 and 4 for southern Ghana and, Mali, and Nigeria, respectively. In the southern Ghana, Mali, and Nigeria markets, consumers paid a premium for large-sized cowpea grains as evidenced by the fact that the coefficients for grain size are positive and statistically significant in all markets except the Lagos market in Nigeria (Table 3 and 4). For a one gram increase in the 100 grain weight, consumers paid between \$US 0.0042 and \$US 0.0261 per kilogram extra in the southern Ghana markets. In Mali, consumers paid between \$US 0.0333 and \$US 0.0337 per kilogram extra for every gram increase in 100 grain weight. Nigerian consumers paid between US\$0.0028 and US\$0.0047 more per kilogram for large-sized compared to small sized cowpea. We were not surprised to learn that the grain size coefficient was not statistically significant in the Lagos market because Lagos is a cosmopolitan city (Langyintuo et al., 2003) where the demand for all sizes and types of cowpeas exists for various household uses.

Coefficients for grain damage, as measured by the number of bruchid holes per 100 cowpea grains, were expected to have a negative sign. The damage coefficient was negative but not statistically significant different from zero for the Malata, Nima, and Asafo markets in southern Ghana as well as for the Lagos market in Nigeria and *Marché de Sabalibougou* market in Mali. The damage coefficient had a positive sign contrary to the expectation in the following markets: Makola, Kaneshie, and Central in Ghana; Maiduguri and Kano in Nigeria; and *Marché de Médine* in Mali. The statistically insignificant coefficients for bruchid damage are consistent with previous studies (i.e., Faye et al., 2006; Langyintuo, Lowenberg-DeBoer, & Arndt, 2005). Evidence suggests that cowpea merchants sort cowpeas to remove damaged grains. In West African markets, it is common to see retailers sorting grains in between customers. The discount for damage also probably depends on the type of food being prepared. Bruchid holes would be visible in foods that use whole cowpeas but unnoticeable in products that use milled cowpeas (e.g., *kosai* or *akara*).

Originally, it was hypothesized that both West and Central African consumers were sensitive to storage damage only if the number of holes was over some threshold (e.g.,

TABLE 3. Estimated Regression Coefficients for Selected Markets in Southern Ghana

Variable name	Markets					
	Accra			Kumasi		
	Makola (n = 80)	Kaneshie (n = 80)	Malata (n = 80)	Nima (n = 80)	Central (n = 80)	Asafo (n = 80)
Grain size	0.0236*** ^a	0.0261***	0.0226***	0.0178***	0.0042*	0.0062***
Number of holes	0.0003	0.0010	-0.0002	-0.0010	0.0005	-0.0002
Skin color	-0.0466	-0.0307	-0.0590*	-0.0045	-0.0194	-0.0003
Skin texture	-0.0913**	-0.1107***	-0.0361	-0.0839**	-0.0135	-0.0181
Eye color	-0.0012	-0.0183	-0.0167	-0.0457**	-0.0280**	0.0028
Month dummies						
January	-0.0098	-0.0326	-0.0141	-0.1259**	0.0995***	0.1526***
February	0.1043**	0.0804*	0.1509***	0.1095**	0.1141***	0.1273***
March	0.0669	0.0072	0.1134***	0.0866*	0.1159***	0.1134***
April	-0.0471	-0.1061*	0.1548***	-0.0254	0.1840***	0.1749***
May	0.1443**	0.1526***	0.2005***	0.1897***	0.1671***	0.1777***
June	0.0511	0.0252	0.1398**	0.0404	0.1357***	0.1607***
July	0.1674***	0.0883	0.1838***	0.1022*	0.1972***	0.1597***
August	0.2933***	0.2054***	0.3181***	0.1578***	0.1354***	0.1640***
September	0.2156***	0.1557***	0.2890***	0.2182***	0.0635**	0.1185***
October	-0.0053	-0.0015	0.0101	-0.0224	0.0587**	0.0473**
December	-0.0930*	-0.0220	-0.0288	-0.0646	0.1241***	0.0955***
Year dummies						
2001	0.1504***	0.1401***	0.2033***	0.1527***	0.0337**	0.0295*
Constant	0.2559***	0.2470***	0.1781***	0.3466***	0.3063***	0.2819***
R-square	0.61	0.64	0.66	0.54	0.54	0.57

Note: Individual country study (Mishili, 2005).
^aStatistical Significance (***1%, **5%, *10%).

TABLE 4. Estimated Regression Coefficients for Selected Markets in Nigeria and Mali

Variable name	Markets				
	Nigeria		Mali		
	Iddo (Lagos) (<i>n</i> = 155)	Monday (Maiduguri) (<i>n</i> = 155)	Dawanau (Kano) (<i>n</i> = 155)	Marché de Sabalibougou (<i>n</i> = 120)	Marché de Médine (<i>n</i> = 120)
Grain size	0.00001	0.0047***	0.0028**	0.0333***	0.0337***
Number of holes	-0.0002	0.0009	0.0009	-0.0003	0.0001
Skin color	0.0298***a	0.0363***	0.0289***	-0.0260***	0.0011
Skin texture	-0.0484***	-0.0205	-0.0056	0.0038	-0.0195*
Eye color	0.0065	-0.0345***	-0.0307***	0.0150	-0.0214
Month dummies					
January	0.0791***	0.0065	0.0922***	0.0055	0.0242
February	0.1006***	0.0345	0.1127***	—	—
March	0.1387***	0.0447**	0.1657***	0.1625***	0.1317***
April	0.2449***	0.0857***	0.1555***	0.1776***	0.1072***
May	0.2598***	0.1471***	0.1713***	0.0279	0.0029
June	0.2561***	0.1453***	0.1732***	0.0626***	0.0549***
July	0.2570***	0.1453***	0.2253***	0.0101	-0.0210
August	0.3380***	0.0987***	0.2365***	0.0441**	0.0488**
September	0.3361***	0.1350***	0.1918***	0.1150***	0.0822***
October	0.3473***	0.0633***	0.1089***	0.0467***	0.0580***
December	0.0251	0.0037	0.0698***	-0.0090	-0.0214
Year dummies					
1998	0.0186*	-0.0130	0.0186**	—	—
1999	—	—	—	-0.0452***	-0.0403**
2000	-0.0009	-0.0028	0.0074	—	—

TABLE 4. Continued

	Markets					
	Nigeria			Mali		
	Iddo (Lagos) (n = 155)	Monday (Maiduguri) (n = 155)	Dawanau (Kano) (n = 155)	Marché de Sabalibougou (n = 120)	Marché de Médine (n = 120)	
2001	—	—	—	0.1307***	0.1184***	
Constant	0.2263***	0.1257***	0.1713***	-0.0653**	-0.0250	
R-square	0.83	0.61	0.78	0.84	0.87	

Note: Individual country studies (Jamal, 2005; Shehu, 2003).

^aStatistical significance (***) 1%, ** 5%, * 10%.

30% of grains damaged). Statistically, accounting for damage thresholds did not improve the explanatory power of the models in any of the three countries. The best models assume that consumers expect a discount from the very firstbruchid hole.

The coefficient for grain eye color was negative and statistically significant in some of the markets in southern Ghana and Nigeria. In southern Ghana, consumers in the Nima and Central markets pay US\$ 0.0457 and US\$ 0.0280 per kilogram less for black-eyed cowpeas compared to other eye colors. These results were statistically significant (Table 3). In the Maiduguri and Kano markets in Nigeria, consumers discount black-eyed cowpeas by \$US 0.0345 and \$US 0.0307 per kilogram, respectively (Table 4).

Consumers, in the markets studied, preferred cowpeas with smooth skin. The coefficient for skin texture is negative and statistically significant for the Makola, Kaneshie, and Nima markets in southern Ghana (Table 3), the Lagos market in Nigeria, and Marché de Médine in Mali (Table 4). For the other markets in Ghana and Nigeria, skin texture was usually negative but not statistically significant different from zero. In the Marche de Sabalibougou market in Mali, the coefficients for skin texture were positive but not statistically significant different from zero. Skin texture preferences are related to the food prepared: Smooth-skinned cowpeas are best for dishes that use whole cowpeas and rough-textured cowpeas are easier to dehull and hence are preferred for foods requiring dehulling and milling.

Consumers discounted white cowpeas in all markets in southern Ghana, and the results are negative and statistically significant in Malata market (Table 3). In Mali, consumers discount white cowpeas in the Marché de Sabalibougou market, and the results are statistically significant (Table 4). The cowpea consumers in the surveyed markets in Nigeria seem to prefer white grains to other-colored grains. The results for white skin color were positive and statistically significant in all markets in Nigeria (Table 4). The statistically significant premium ranged from US\$0.0289 to US\$0.0363.

Difference analyses were done to check for the need for a different functional form. It was observed that there was no advantage of increasing the explanatory power of the model with different functional forms. The Appendix reports the results of the Box-Cox transformation procedure. Column two reports the suggested power of transformation for both sides of the Box-Cox model with same parameter as well as the likelihood ratio tests for the hypotheses that the Box-Cox parameter is -1 , 0 , and 1 . The Box-Cox tests for the Makola, Kaneshie, and Malata markets indicate that no transformation is needed. The Box-Cox results in the other markets are unclear as to what model transformation is best. This study, therefore, implemented the linear regression model analysis for all the markets to study the influence of the grain quality characteristics on the market price of the grain in a consistent manner.

7. IMPLICATION OF RESULTS

Because price levels differ from market to market, comparisons are facilitated by expressing the hedonic coefficients as a percentage of the average price in the market for the data period (Table 5). Consumers in southern Ghana paid a premium, between 1.0% and 4.4% of the average grain price per kilogram for every increase of grain size by one gram per 100 grains. In Mali, consumers paid a premium, between 8.6% and 8.8% of the average grain price per kilogram for every increase of grain size by one gram per 100 grains. In Nigerian markets, the range of price premiums is

TABLE 5. Percentage Price Change^a per kg in the Southern Ghana, Mali, and Nigerian Markets

Country/market	Grain size	No. of holes	Skin color	Skin texture	Eye color
	Percentages (%)				
Southern Ghana					
Makola (Accra)	+4.0*** ^b	+0.05	-7.9	-15.5**	-0.2
Kaneshie (Accra)	+4.4***	+0.2	-5.1	-18.4***	-3.1
Malata (Accra)	+4.0***	-0.04	-10.4*	-6.3	-2.9
Nima (Accra)	+3.0***	-0.2	-0.8	-14.2**	-7.7**
Central (Kumasi)	+1.0*	+0.1	-4.6	-3.2	-6.6**
Asafo (Kumasi)	+1.3***	-0.04	-0.1	-4.0	+0.6
Mali					
Marché de Sabalibougou	+8.8***	-0.1	-6.9***	1.0	4.0
Marché de Médine	+8.6***	0.03	0.3	-5.0*	-5.5
Nigeria					
Iddo (Lagos)	+0.002	-0.04	+6.9***	-11.2***	+1.5
Monday (Maiduguri)	+1.6***	+0.3	+12.7***	-7.2	-12.0***
Dawanau (Kano)	+0.8**	+0.3	+7.9***	-1.5	-8.4***

Note: Individual country studies (Jamal, 2005; Mishili, 2005; Shehu, 2003).

^aPercentage values were calculated as $(\beta_i/\text{av. price in market } i) \times 100$.

^bStatistical significance of the coefficient (***1%, **5%, *10%).

between 0.8% and 1.6% of the average grain price per kilogram for every increase of grain size by one gram per 100 grains.

The cowpeas with black eyes resulted in the price discount between 6.6% and 12.0% in the Nima, Central, Maiduguri, and Kano markets (Table 5). Rough-textured skin cowpeas resulted in a price discount of 15.5%, 18.4%, 14.2%, and 11.2% of average cowpea price per kilogram in the Makola, Kaneshie, Nima, and Lagos markets, respectively. White-skinned cowpeas resulted in a price discount in the Malata and Marché de Sabalibougou markets for 10.4% and 6.9% of average cowpea price per kilogram. In Nigerian markets, white-skinned cowpeas resulted in price premium in the range of 6.9% and 12.7% of average cowpea price per kilogram (Table 5).

8. CONCLUSIONS

Consumers in the Nigerian, Ghanaian, and Malian markets that were studied nearly universally preferred a larger cowpea size. For statistically significant coefficients, the premium per gram for the larger grain size ranged from 0.8% to 8.8% of the average price. None of the markets had the coefficients for bruchid damage statistically significant. However, five of the markets had an expected negative sign on the coefficients for bruchid damage. Preferences for eye color, skin texture, and color preferences varied widely from market to market.

The hedonic price analysis estimates for the variables of grain size and damage reported here for urban areas are similar to previous studies done in cowpea production areas. For example, Langyintuo et al. (2003) reported that consumers in the northern Ghana markets pay a premium of \$US 0.005 kg⁻¹ per gram of 100 grain weight. This premium ranged from 1.2% and 1.4% of the average cowpea

price. In the Bolgatanga market in northern Ghana, it was estimated (Langyintuo et al., 2003) that price is discounted about 1.2% per bruchid hole. This discount in the Bolgatanga is approximately \$US 0.0048 kg⁻¹ for bruchid hole. In Senegal, Faye et al. (2006) showed that grain-size premiums per gram ranged from 1% to 16%, while the only statistically significant damage discount was about 0.37% of average grain price per bruchid hole.

The cowpea hedonic pricing analysis for Nigeria, Ghana, and Mali reported here suggests that efforts to improve cowpea markets in West Africa should target the cowpea grain size. Consumers in this and other studies almost universally preferred larger cowpeas. The number of bruchid holes is not statistically significant in any market. This may be the result of merchants sorting out and discarding enough damaged grains to avoid consumer adverse reaction. Researchers and technology transfer organizations should offer a portfolio of grain color, eye color, and skin texture to fit local preferences. From the Box-Cox analysis results, there is little evidence to rule out the use of the linear regression model in the study.

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APPENDIX A

A.1 BOX-COX TRANSFORMATION RESULTS

Country/market	<i>P</i>				Suggested model forms (at conventional 5%)
	Model (λ)	($\lambda = -1$)	($\lambda = 0$)	($\lambda = 1$)	
Test H ₀ : for $\lambda = -1, 0, 1$					
Ghana					
Makola (Accra)	0.6 ^{*a}	0.000	0.070	0.205	Linear/log
Kaneshie (Accra)	0.8 ^{***}	0.000	0.011	0.417	Linear
Malata (Accra)	0.9 ^{**}	0.000	0.013	0.730	Linear
Nima (Accra)	0.2	0.000	0.540	0.025	Log
Central (Kumasi)	-0.4	0.193	0.376	0.004	Log/reciprocal
Asafo (Kumasi)	0.1	0.000	0.638	0.012	Log
Mali					
Marché de Sabalibougou	-0.2	0.000	0.136	0.000	Log
Marché de Médine	-0.01	0.000	0.863	0.000	Log

Nigeria					
Iddo (Lagos)	-0.4**	0.001	0.046	0.000	Log
Monday (Maiduguri)	-0.2	0.000	0.290	0.000	Log
Dawanau (Kano)	0.1	0.000	0.660	0.002	Log

Note: The Box-Cox implemented was “both sides Box-Cox model with the same parameter.” The test statistic is based on the restricted log likelihood model. *P*-values reported are for LR statistics.

^aStatistical significance of the model λ coefficient (***1%, **5%, *10%).

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