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Urban consumer preferences and sensory evaluation of locally produced and imported rice in West Africa

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Abstract

Parboiled rice produced in Ghana is of poor quality and is being overtaken by imported rice. This study sought to investigate consumer preference and relate sensory attributes with consumer acceptability of rice. The majority of consumers preferred imported raw and parboiled rice to that produced locally. Acceptability was influenced by location and gender. Individual preferences of consumers varied and four different segments of consumers with similar liking of rice were identified. The largest three segments (86% of consumers) preferred the imported rice but differed in their preferences for the local rice. A niche segment (14%) mostly preferred traditional local rice. The youngest segment of consumers was the most likely to purchase imported rice while the older segments generally purchased local parboiled rice. Internal preference mapping indicated that consumers were less selective than the sensory panel. Regression models to predict consumer preference from the sensory panel scores were based on either brown colour of the cooked rice or unshelled paddy in the uncooked form. However, the models were only valid for 66% of the consumers suggesting that while a sensory panel could be used to rapidly monitor consumer acceptability in product development, it was not valid for all consumers. The implications of these findings are discussed.

Keywords: Consumer acceptability, Sensory evaluation, Rice, Ghana, Africa.

1. Introduction

Rice (*Oryza sativa* L.) is an important food for urban consumers in Ghana and West Africa and is taking over from traditional staples, mainly root crops such as yam and cassava (Asafo, 1985). The per capita consumption of rice is second only to maize among cereals in Ghana (Bam *et al.*, 1998). About 281,000 tons of milled rice in produced annually in Ghana (Anon, 1998) but it has been estimated that about 200,000 tons of rice is imported (Day *et. al.*, 1997). While most of the imported rice is in the raw form, it is estimated that 46% of locally produced rice is parboiled. As many as 120,000 women are involved in the production of parboiled rice, which is, however, of poor quality and trades at about half the price of that imported (Quaye *et al.*, 2000).

Parboiling is a steam treatment of paddy that alleviates the effects of poor drying (cracking) and improves yield quantitatively and qualitatively since the proportion of broken grains is reduced. (Diop & Wanzie, 1990). The cooking quality of parboiled rice is better because the grains stay firm and do not stick together. The rice is also more

nutritious because the proteins and vitamins are diffused through the centre of the grain after parboiling and stores better thanks to its greater hardness. Only its stronger flavour and yellowish colour could be disadvantages (Pillaiyar, 1990; Garibaldi, 1985). In Ghana and Nigeria, parboiling is accomplished by soaking in hot water, steaming at ambient pressure, drying and milling the rice.

Little has been reported on the consumer preference of rice in Ghana. Priestly (1994) reported that cooked grains should be firm and non-sticky. In Brazil (Luz & Treptow 1994) found that consumers preferred parboiled to milled rice although most consumers generally ate milled rice. In Sri Lanka, factors influencing preference were percentage of head rice, shape of milled rice and aroma (Kotagama & Kapila Jayantha Kumara 1996). In the Philippines, milled rice that had a soft texture was preferred (Del Mundo & Juliano 1981). Schutz & Damrell (1974) reported a high correlation between hedonic ratings by US consumers and sensory attributes by a trained panel of six. Sensory attributes relating to palatability were dryness, stickiness, rubberiness, starchiness, rice flavour and compactness.

Ghana is a multi-ethnic society with five major ethnic groups. This presents difficulties when developing or improving a product because consumer preferences may differ widely. This study seeks to determine if consumer acceptability of rice differs with location in Ghana and how acceptability differs within these groups. The sensory factors influencing acceptability will be investigated and models that predict consumer acceptability from these sensory attributes will be determined. This will assist with the development of processing methodologies to improve the quality of parboiled rice produced by small-scale rural processors in Ghana and may help to focus marketing strategies.

2. Materials and Methods

2.1 Samples

The six samples of rice selected for the study and some characteristics are as follows:

a) US (United States) imported raw rice (US No 5) - widely available in Ghana
b) US imported parboiled rice (Tilda) - premium product limited to a few supermarkets
c) Parboiled rice produced and purchased in the Upper East Region of Ghana - generally considered to be the best quality local product because the rice is extensively sorted and graded by market traders.
d) Parboiled rice purchased in Accra, Ghana - average quality local product that has undergone limited sorting and clean-up
e) Parboiled rice purchased in Kumasi, Ghana - average quality local product that has undergone limited sorting and clean-up
f) Parboiled rice purchased and processed in Tamale, Ghana - average quality local product that has undergone limited sorting and clean-up

2.2 *Cooking method*

Rice (300 g) was washed in water (300 ml) of water and drained for five minutes. The samples were cooked in 450 ml salted water (3 g salt in 1000 ml water) and the heat was reduced in the last 10 minutes of cooking. The cooking times (according to local cultural practices) were 30 min for the American raw, American parboiled, parboiled from Upper East and parboiled from Accra. The parboiled samples from Kumasi and Tamale were cooked for 35 min. Cooked rice was kept in a heated box (60°C ±5°C) for up to one hour until served.

2.3 *Consumer acceptability methodology*

Consumers (300) were interviewed at three locations (Accra, Kumasi and Tamale) in Ghana using the method of central location testing. Consumers were selected according to gender and ages from 18 to 70 years.

During testing, cooked rice samples were freshly prepared after every hour. Consumers scored the acceptability of rice using a 9-point hedonic box scale (Meilgaard *et al.*, 1987) from 'dislike extremely' to 'like extremely'. Cooked rice samples were coded with 3-figure random numbers and presented simultaneously, but in random order, to each consumer on white paper plates.

After scoring the acceptability of the rice, consumers were interviewed. This recorded information on gender, age, occupation, how often they consumed rice, where they eat rice, which rice they prefer to purchase (local or imported), their preferred staple and who purchases rice in their household. The interview lasted about 30 min.

2.4. *Sensory methodology*

The same rice samples prepared for the consumers were scored by a sensory panel using the method of quantitative descriptive analysis (QDA) (Meilgaard *et al.*, 1987; Bainbridge *et al.*, 1996). The sensory panel (10 panellists) was conducted at the Food Research Institute (FRI), Accra, Ghana under controlled temperature (air conditioned) and lighting. Sensory attributes for uncooked (visual and odour) and cooked (visual, odour, taste and texture) rice were generated during a preliminary focus group session guided by the panel leader. A total of 16 uncooked and 14 cooked sensory attributes were developed for which the group had a consensus. Sensory attributes generated for the uncooked product were uniform colour, black specks, white heads, yellow colour, brown colour, cream colour, brightness, translucence, clean appearance, chalky appearance, unshelled paddy (not completed hulled), whole grain shape (as opposed to broken), long shape, oval shape, size and slender. Sensory terms for the cooked rice were brown colour, yellow colour, whitish appearance, black specks, uniform appearance, typical rice odour, sweet taste, sour taste, creamy taste, sticky texture, grainy texture and hard texture.

At each sensory panel, three rice samples (coded with 3-figure random numbers) were served in random order. Samples (40 g) were close to room temperature and panellists

rinsed their mouth with mineral water before tasting each sample. Intensity was scored on a 100 mm unstructured scale, anchored with the terms 'not very' at the low end and 'very' at the high end. All rice samples were scored in triplicate (on different days) by each panellist.

2.6. Data analysis

Analysis of variance (ANOVA), correlation analysis, stepwise regression, principal component analysis (PCA; covariance), cluster analysis (agglomerative hierarchical clustering using Wards methods and k-means optimised using the within group variance) and internal preference mapping were computed using SPSS (version 9) and XLSTAT (version 5.1 v3.1).

3. Results and discussion

3.1. Consumer questionnaire

Three hundred respondents completed the questionnaire and socio-economic indicators of the consumers at each location are given in table 1. The gender and age of the consumers interviewed was evenly mixed at Accra and Kumasi whereas more females were interviewed at Tamale. Most (35% to 45%) consumers ate rice 20 or more times a month. Women (63% to 80%) mostly purchased the rice, which suggests that advertising and dissemination of an improved local product might be more successful if focused on women. With respect to income, the proportion of those on medium, low and student incomes was similar (25% to 29%) at each location, followed by higher income earners (18%) and the unemployed (1%).

When consumers were asked whether they preferred to purchase local or imported rice, the majority (53% to 70%) of consumers preferred imported rice but the proportion was least at Tamale. Tamale is situated in the North of Ghana where local parboiled rice is widely produced whereas Accra and Kumasi are urban centres in non-rice producing areas.

Most consumers (60% to 76%) ate rice at home followed by work (8% to 22%), street foods (6% to 14%) and school (4% to 7%).

The preferred staples varied at each location being rice (36%), plantain (22%) and maize (21%) at Accra, plantain (28%), rice (25%) and maize (18%) in Kumasi and maize (36%), rice (31%) and yam (13%) in Tamale.

3.2. Evaluating if sufficient consumers were interviewed in order to obtain a consistent result

The cumulative mean acceptability was plotted against the number of consumers for each location (100) . An example is given in figure. 1. Initially, the addition of more consumer scores to the cumulative mean caused large fluctuations in the mean acceptability. After between 50 and 80 consumers were included, however, the trend for

consumer acceptability for each sample remained constant indicating that interviewing 100 consumers at each location yielded a consistent result.

3.3. Consumer acceptability of rice.

Consumer acceptability differed significantly with respect to rice and location (P=0.015; Figure 2), gender and location (P=0.042) and rice and gender (P=0.021). The largest F-statistic (155.4, 5 degrees of freedom [df]) was for the main effect of rice sample indicating that this was the main factor influencing consumer acceptability. This was followed by location which had a smaller F-statistic of 3.2 (5 df). Gender was significant as an interaction with rice and location.

The imported US rice (raw and parboiled) were the most preferred by consumers at all three locations followed by the rice from Upper East, then Accra, then Kumasi and lastly the rice from Tamale. Considering the local rice samples from each region, consumers tended to like the samples that came from their own region. Accra consumers had the highest preference for local rice purchased from Accra markets, Kumasi consumers for Kumasi markets and Tamale consumers for rice purchased at Tamale and Upper East which are both rice producing areas.

Consumer acceptability differed with gender and location. Whereas the liking for males was consistent with location (the mean score varied between 6.1 and 6.2), liking for females differed being least at Accra (5.5) and most at Tamale (6.3). Women tended to prefer the imported raw and parboiled rice whereas men tended to prefer the local rice (Accra, Upper East and Tamale). However, these differences, although significant, were small.

3.4. Segmentation of consumer preference

The individual preferences of the 300 consumers interviewed varied and are illustrated in the principal component plot (accounting for 67% of the variability) in figure 3. Most consumers had their strongest preference for the US raw and imported rice in the right hand quadrants. Fewer consumers (left hand quadrants) had a strong preference for the parboiled rice from Tamale and Kumasi. The consumers were segmented into four groups of similar liking for the six rice samples using K-means cluster analysis.

The preferences for rice of the consumer segments significantly differed (P<0.001) and the mean preference is given in figure 4 and are shown as numbers on the individual consumer PCA plot in figure 3. The largest segment of consumers (segment 4) represented 34% of consumers. They had a strong liking from the imported rice, moderately liked the local rice from Upper East and Accra, liked a little the rice from Kumasi and were neutral about the Tamale rice. The next largest group (segment 1, 32% of the consumers) also had a strong liking for the imported rice, liked the local samples from Upper East and Accra but disliked a little or moderately the local samples from Kumasi and Tamale. Segment 2 (20%) strongly liked the imported rice, liked the local rice from Upper East, Accra and Kumasi a little but disliked the Tamale rice. Segment 3 (niche) comprised the smallest (14%) group of consumers and differed because they had a strong liking for the Tamale rice.

In each segment, the proportion of consumers from each location was similar and suggests a marketing strategy for an improved rice would be simplified.

The consumers in the segments significantly differed with respect to age (P=0.002; segment 1 = 28.7, segment 2 = 31.8, segment 4 = 33.2 and segment 3 = 35.2 years) and whether they preferred to purchase imported or local rice (P=0.001; segment 1 = 77%, segment 2 = 75%, segment 4 = 65% and segment 4 = 43%). Consumers in segment 3 were generally older (35 years) and were the least likely to purchase imported rice (43%).. Conversely, segment 1 was younger (29 years) and was the most likely to purchase imported rice (77%).

This has implications in the development and marketing of an improved parboiled rice. An improved local rice might appeal more to segments 1, 2 and 4 which combined represent 86% of consumers. They have a clear preference for imported rice and tend to not like local rice, tend to be younger and already prefer to purchase imported rice. These groups will be the most demanding with respect to quality and the improved local rice would have to meet their requirements if they were to purchase it. Conversely, there is a clear niche market for the traditionally produced parboiled rice since segment 3 clearly prefers this rice and tends to be older.

3.5. Sensory analysis

The sensory attributes of the rice samples differed (P<0.001) for 11 cooked and 14 uncooked sensory attributes. Typical rice odour, oval shape and size did not significantly differ and were excluded from further analysis.

Cooked rice sensory attributes

The PCA of the correlation matrix for cooked rice (figure 5) resulted in a two factor solution accounting for 95% of the total variation of which 78% was explained by the first principal component (PC) and 17% by the second. In the plot spanned by the first two PC scores, samples were separated according to appearance and texture along the sensory direction from left to right and by colour (white to yellow) from up to down. The local parboiled rice samples from Tamale, Kumasi and Upper East were in the lower left quadrant and similar to each other. The local Accra sample was in the upper left sector. The imported parboiled and imported raw rice samples where in the upper and lower right quadrants respectively.

The axis relating to separating the local rice and imported samples was from left to right. It spanned between uniform appearance, attractive odour, rice odour, creamy taste and sweet taste which were associated with imported rice and hard texture, grainy texture, sour taste, brown colour and brown specks which were associated with the local rice samples. From the vertical direction, the imported parboiled and local Accra rice were associated with yellow colour and the imported raw rice was allied with white colour and sticky texture.

Uncooked rice sensory attributes

The PCA of the correlation matrix for uncooked rice (figure 6) resulted in a two factor solution accounting for 94% of the total variation of which 65% was explained by the first principal component (PC) and 29% by the second. In the plot spanned by the first two PC scores samples were separated according to appearance and shape along the sensory direction from left to right and by colour (yellow to white) from up to down. The local parboiled rice samples from Accra, Tamale, Kumasi and Upper East were divided along the border between the upper and lower right-hand quadrants. The imported parboiled and imported raw rice samples where in the upper and lower left quadrants respectively. Whereas the local rice samples from Accra and Upper East were separated with respect to cooked attributes, there were similar for uncooked attributes.

The axis relating to separating the imported and local rice samples was from left to right. It spanned between long shape, brightness, uniform appearance and whole-grain shape which were associated with imported rice and slender, brown, unshelled paddy and black specks which were associated with the local rice samples. From the vertical direction, the imported parboiled rice was associated with yellow colour and size, and the imported raw rice was allied with white specks and chalky.

3.6. Internal Preference Mapping

The mean scores for the sensory attributes generated by the sensory panel were related to the individual preferences of individual consumers. The PCA plots, accounting for 67% of the variability, are shown in figure 7 and are based on the liking of each individual consumer. Compared to the sensory panel, the consumers were less selective, perceiving the rice in a one dimensional manner; that is the sensory attributes are either in a similar (proportional) or opposite (inverse) direction. The sensory attributes lay in the direction of PC1 (55% of variability) and the most acceptable samples (US parboiled and raw) were in the right-hand quadrant. They were positively associated with the cooked attributes sticky, rice odour, creamy sweet uniform appearance, whitish and yellow and the uncooked attributes yellow, long shape, creamy appearance, bright, clean, uniform appearance whole grain shape and white specks. The other cooked and uncooked sensory attributes were inversely associated apart from the uncooked attributes chalky and size.

Considering the consumer segments, 1, 2 and 4 tended to be most strongly associated with the cooked and uncooked sensory attributes in the right hand quadrants and negatively associated with brown colour and black specks. The niche segment 3 was situated in the left-hand quadrant being associated with the cooked attributes brown and black specks and the uncooked attributes unshelled paddy.

3.7. Models to relate consumer acceptability with the sensory attributes used by the panel

External preference mapping (Guinard et al 2001) has been recommended for relating consumer preference to sensory attributes and instrumental measures and can assist in the formulation of new products. However, in this study, the number of variables was insufficient for this approach to be applied. Therefore regression methods were used.

Cooked sensory attributes

Stepwise linear regression indicated a simple model for predicting consumer acceptability (segments 1 4) that only included brown colour. The segments differed in how brown colour correlated with consumer acceptability (figure 8). Consumer acceptability in segment 1 (34%; $R^2 = 0.947$) was the least influenced by increases in brown colour of the cooked rice and segment 4 (34%; $R^2 = 0.957$) was the most sensitive. Instead of using two models, it might be more practical to combine these two segments to reflect the acceptability of 66% of consumers and this regression line is included in figure 8. Suitable models could not be developed for consumers in segments 2 and 3. In these segments, increases in brown colour up to a sensory score of 50 did not influence preference. However, for sensory scores above 50, acceptability was markedly reduced for segment 2, but slightly increased for segment 3. Although consumers in segment 2 (additional 20%) were not included in the model, the fact that their preference was markedly reduced for brown and unshelled paddy scores greater than 50 suggests that the above model would approximate for this segment also.

Uncooked sensory attributes

A similar pattern to the cooked attribute brown colour was noted for the uncooked sensory attribute unshelled paddy (figure 9).

These results indicate that consumer acceptability, using a sensory panel, can be estimated using uncooked and cooked rice but it will only apply to 66% of consumers. Using uncooked rice has the advantages of being simpler and quicker and not subject to variability in cooking. However, sensory evaluation of the cooked rice is still necessary in case changes in the manufacturing process lead to changes in cooked taste that are not apparent in the uncooked form.

Of the 44% of consumers (segments 2 and 3) who were not included in the model, possible reasons why might include:

- Other factors influencing consumer acceptability were not measured by the sensory panel (for example taints and off-flavours);
- Ethnic and cultural differences among the consumers;
- The sensory panel required more training;
- The rice samples selected for the study were too few;
- Natural variation in preference in a given population of people;
- Confusion in understanding the test instructions;
- Wrongly completed scoresheets;
- Variations in the testing conditions used for the consumer trials.

In this study, it was difficult to determine which of the above factors explain the incompleteness of the model and future studies would be required.

3. Conclusions

Consumer acceptability varied markedly with the imported raw and parboiled rice being preferred to locally produced parboiled rice. Of the locally available parboiled rice,

consumers tended to show increased preference for the local rice that was typically sold in their area. There were slight gender differences with women tending to prefer the imported US rice while men tended to prefer the local rice. Women also predominantly purchased rice and should be the focus when marketing an improved parboiled rice in Ghana.

Individual preferences of consumers varied and four significantly different segments (groups) of consumers with similar liking of rice were identified. The largest segments (34%, 32% and 20%) of consumers preferred the imported rice but differed in their preferences for the local rice which varied from tending to find the local rice acceptable to increasing degrees of dislike. The smallest niche segment (14%) of consumers preferred the local rice from Tamale. An improved local rice might appeal most to segments 1 and 2 which combined represent 52% of consumers. They had a clear preference for imported rice and tended to not like local rice, were younger and already prefer to purchase imported rice. Consumers in segment 4 (34%) however, while preferring imported rice, also liked the local rice and hence are expected to readily purchase the improved local rice. Conversely, there is a clear niche market for the traditionally produced parboiled rice by older consumers in segment 3.

The sensory panel found significant differences between the rice samples (uncooked and cooked) and was more selective in using the sensory attributes than consumers as indicated by internal preference mapping. The majority of consumers (segments 1, 2 and 3) preferred rice that was yellow, uniform in colour, sweet, creamy, sticky and has a rice odour. A niche segment (3) preferred rice that was brown in colour and had black specks.

Regression models to predict consumer preference were based on brown colour for the cooked rice and unshelled paddy for uncooked rice. The models developed only applied to segments 1 and 4 representing 66% of consumers. However the model may apply to 86% of consumers because consumers in segments 2, representing an additional 20%, could probably be included in the model because their preferences were similar although not statistically significant.

More needs to be known about the different liking segments. Other factors influencing liking such as ethnic group, how much the consumer can afford to pay may help to distinguish between the segments. Inclusion of questions into the questionnaire regarding attitudes to the media, for example favourite radio, television, newspapers etc, would assist the program in marketing the improved rice when targeting the different segments of consumers.

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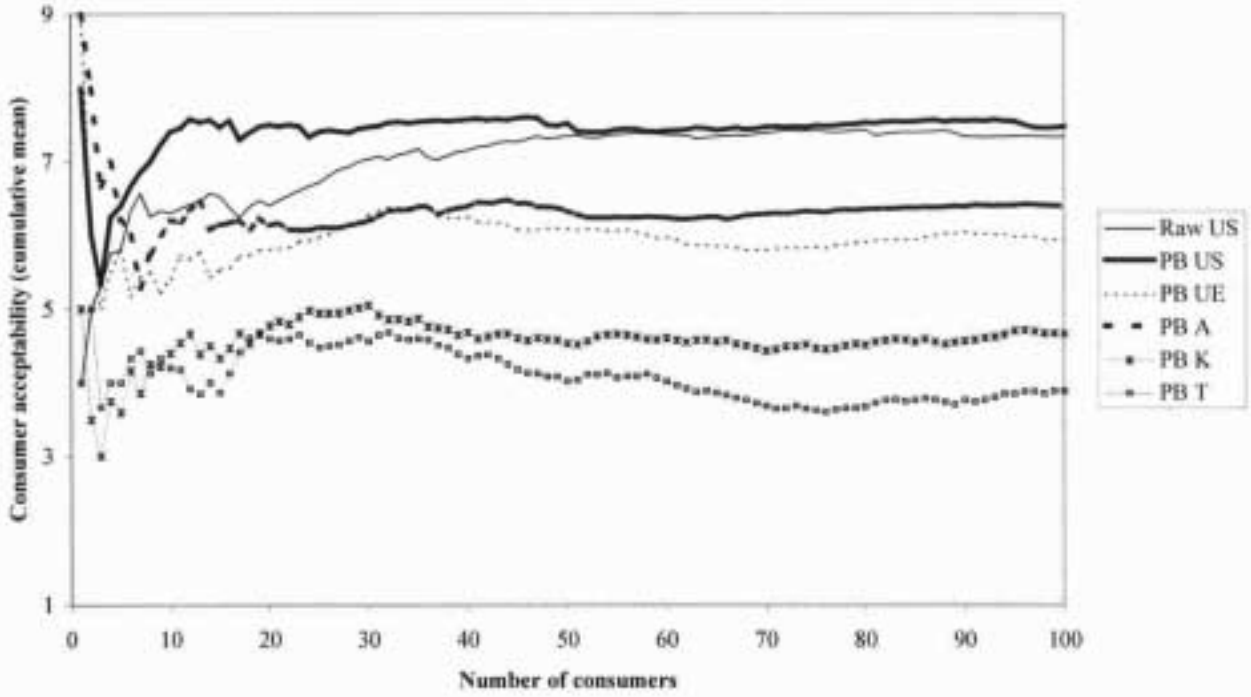
Table 1
Socio-economic profile of consumers interviewed at Accra, Kumasi and Tamale

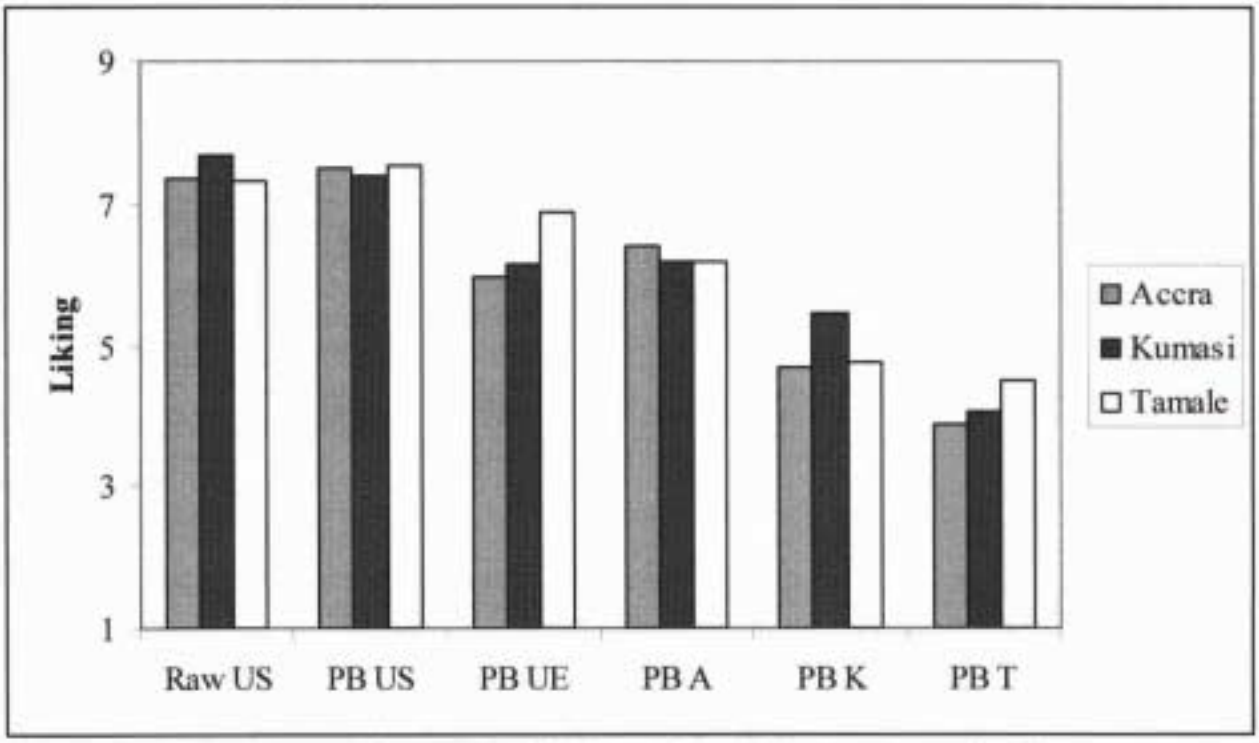
	Total sample		Location (%)		
Demographic variables	**%**	**Number**	**Accra**	**Kumasi**	**Tamale**
Gender					
Male	44	132	50	51	31
Female	56	168	50	49	69
Age					
18 to 29	49	148	59	39	50
30 to 49	42	125	32	50	43
50 to 69	9	26	9	11	7
Times per month consumer eats rice					
0	0	1	1	0	0
1 to 5	26	78	30	13	35
6 to 10	14	43	20	15	8
11 to 15	11	32	9	16	7
16 to 20	8	23	5	11	7
20+	41	123	35	45	43
Who purchases rice					
Woman	72	214	74	80	63
Men	28	83	26	21	37
Children	1	3	0	1	2
Where consumer eats rice					
Home	69	206	76	60	70
Work	13	39	8	22	10
Street food	11	32	6	13	14
School	6	18	7	4	7
Restaurant	2	5	3	1	0
Preference for purchase by consumer					
Imported	62	186	63	70	53
Local	30	91	25	24	42
no preference	8	23	12	6	5
Preferred staple					
Rice	30	91	36	25	31
Maize	25	75	21	18	36
Plantain	18	55	22	28	4
Cassava	11	33	9	18	6
Yam	10	29	6	10	13
Millet/Sorghum	6	17	6	1	11
Income status					
Unemployed	1	4	2	0	2
Student	25	76	23	22	31
Low	29	87	32	25	30
Medium	26	79	25	24	30
High	18	54	18	29	7

Fig. 1
Cumulative mean consumer acceptability plotted against the number of consumers (Accra).



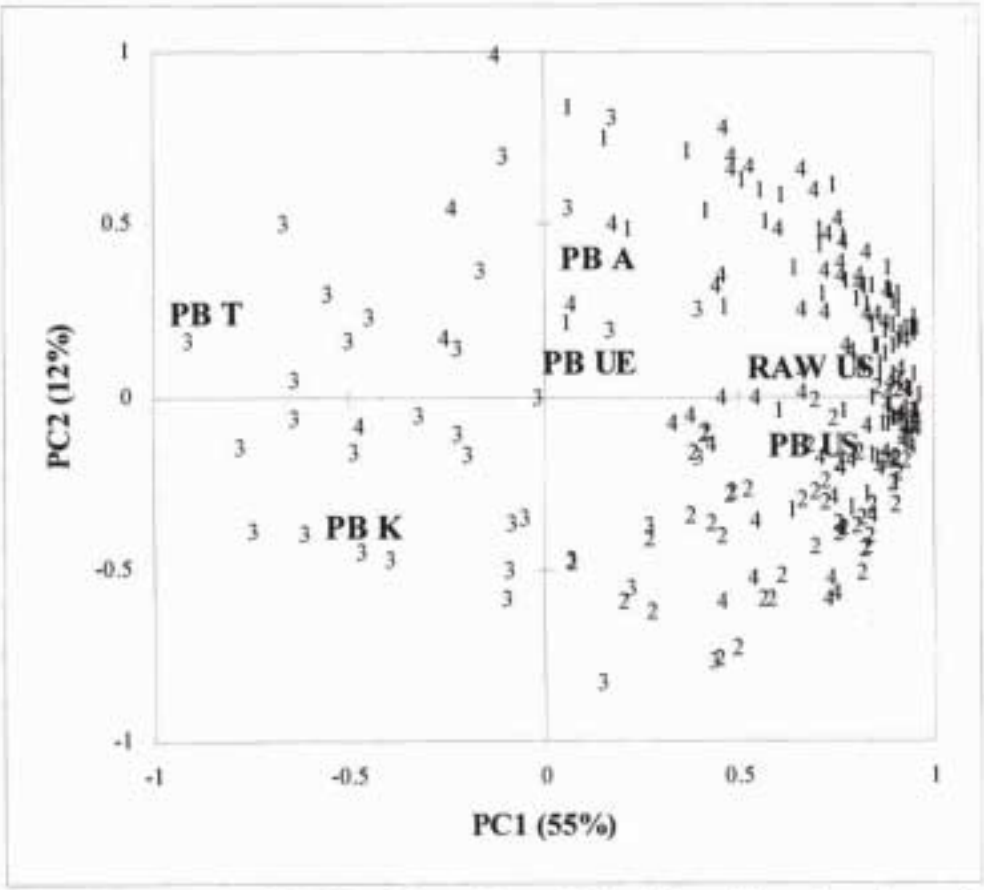
Where: PB = parboiled, US = United State, UE = Upper East, A = Accra, K = Kumasi, T = Tamale

Fig 2
Mean consumer acceptability with rice and location



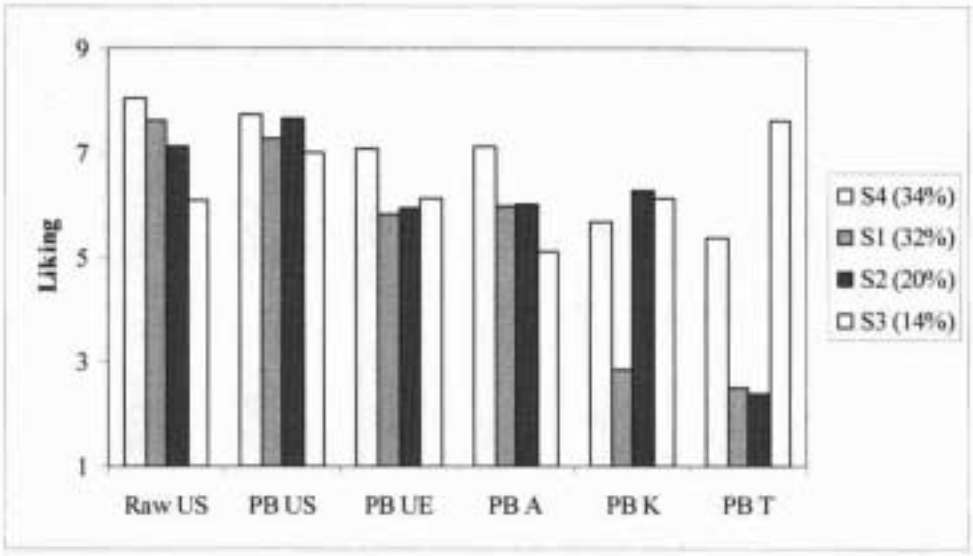
Where US = United States, PB = parboiled, UE = Upper East, A = Accra, K = Kumasi and T = Tamale

Fig 3
Map of individual consumer's preferences for six rice samples



Where: PB = parboiled, US = United State, UE = Upper East, A = Accra, K = Kumasi, T = Tamale
Numbers 1 to 4 represent the segment each individual consumer was fitted to.

Fig. 4
Mean liking for consumer segments.



Where: S1, S2, S3 and S4 are segments comprised of consumers of similar liking, US = United States, PB = parboiled, UE = Upper East region, A = Accra, K = Kumasi and T = Tamale

Fig. 5
Principal component plot for cooked rice sensory attributes

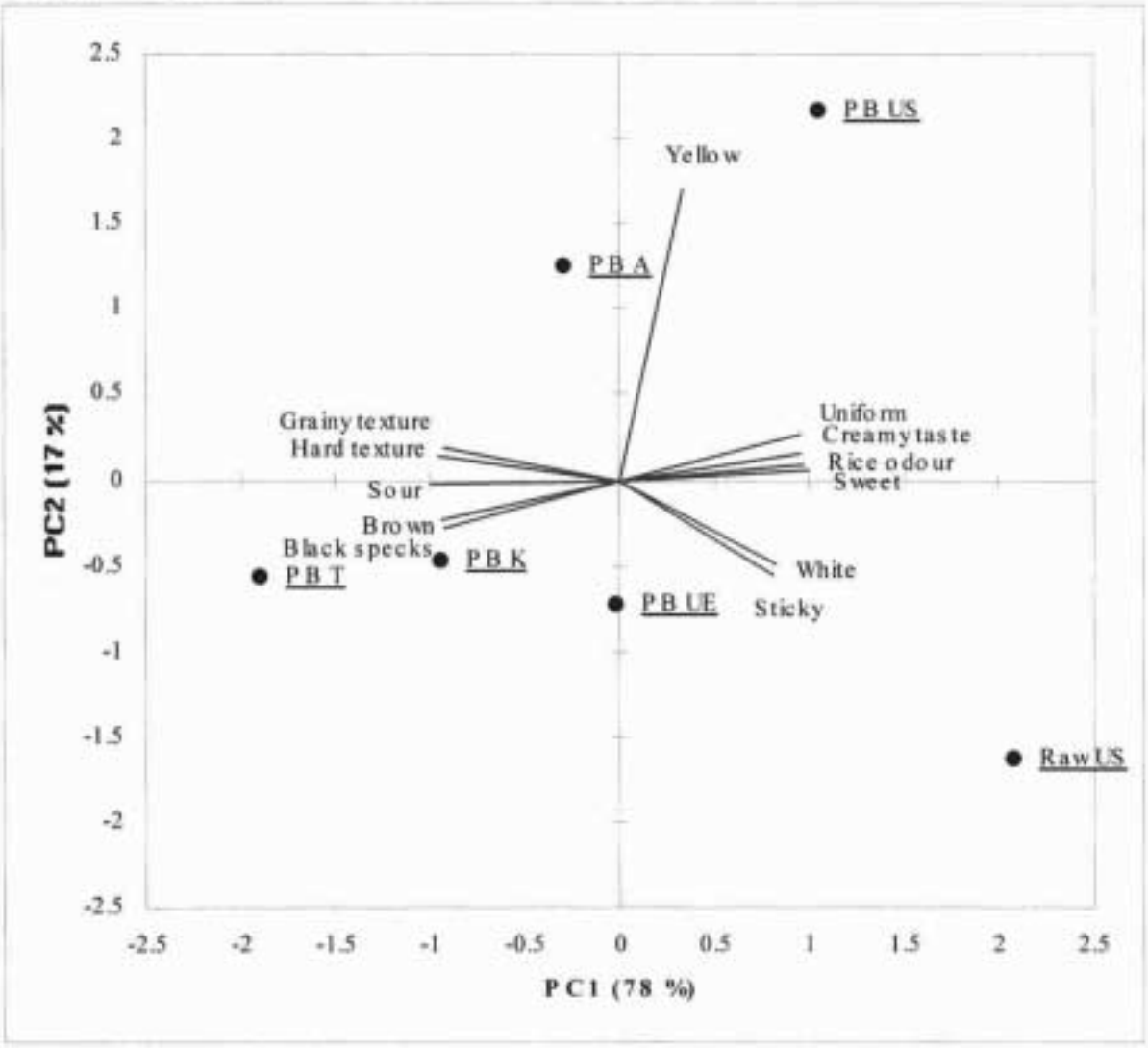


Fig. 6
Principal component plot for uncooked rice sensory attributes

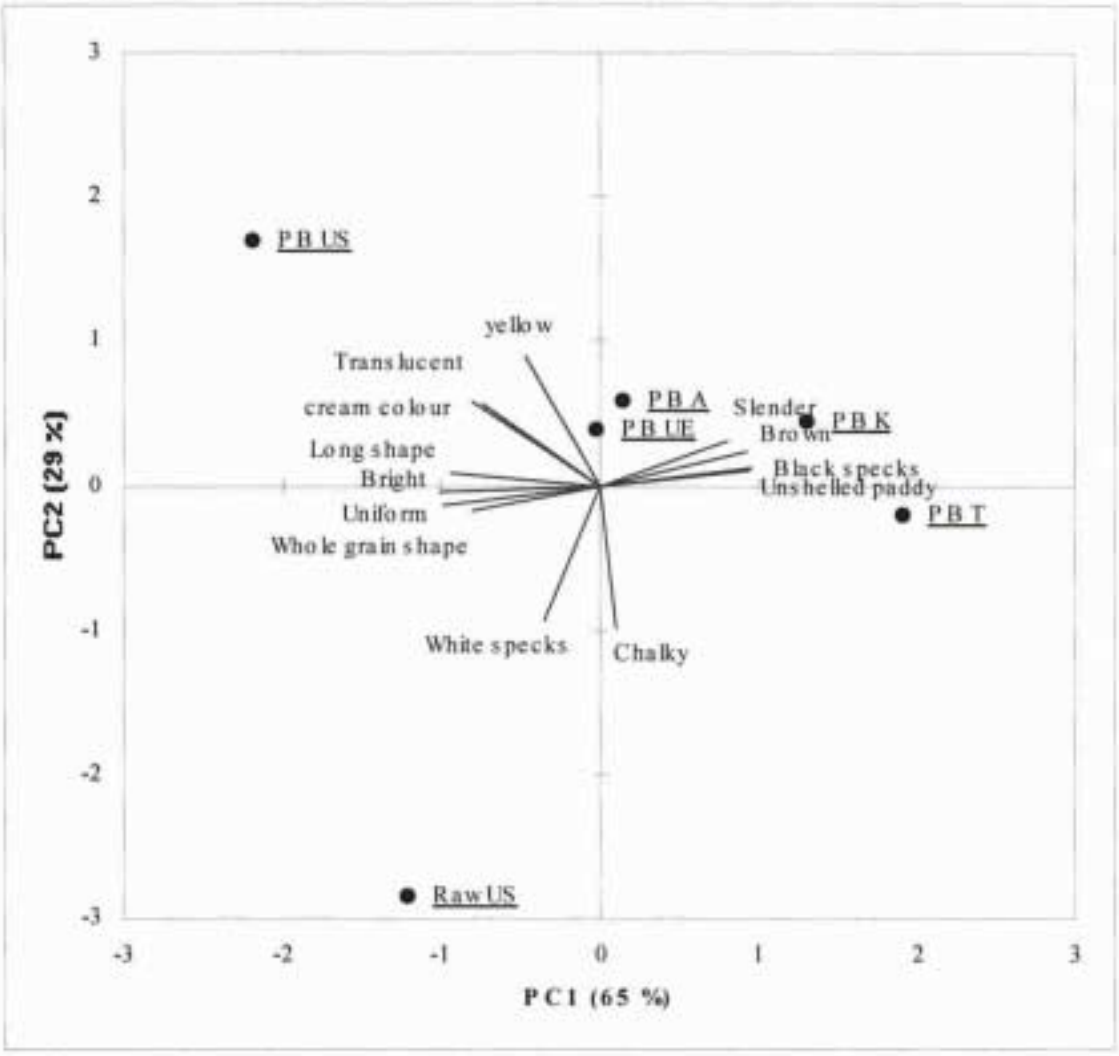
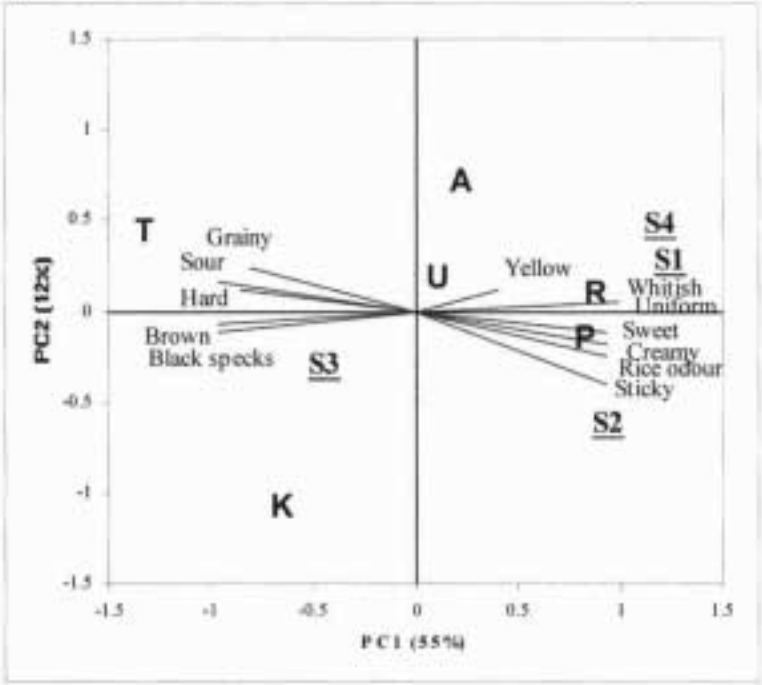


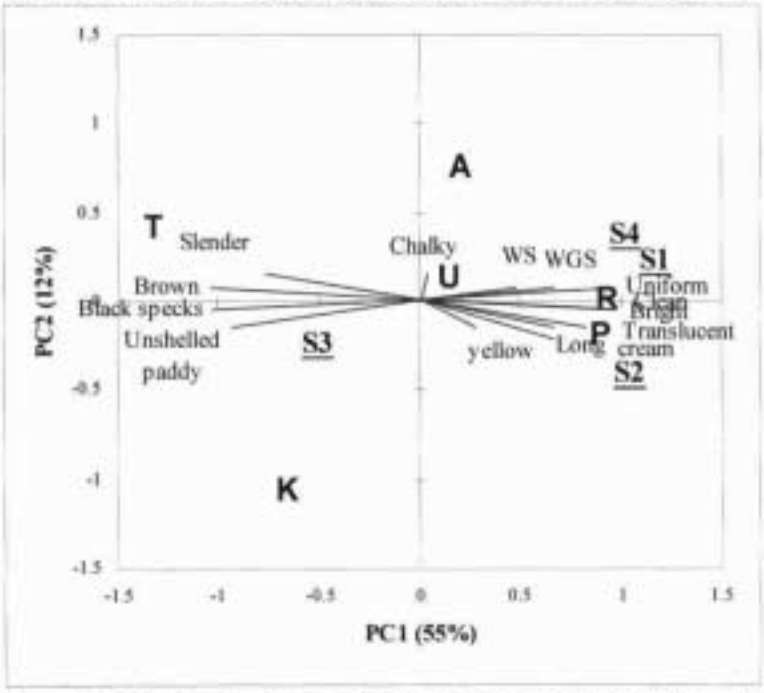
Fig. 7
Internal preference maps showing relationship of means of segments and sensory attributes

a) cooked sensory attributes and consumer segments



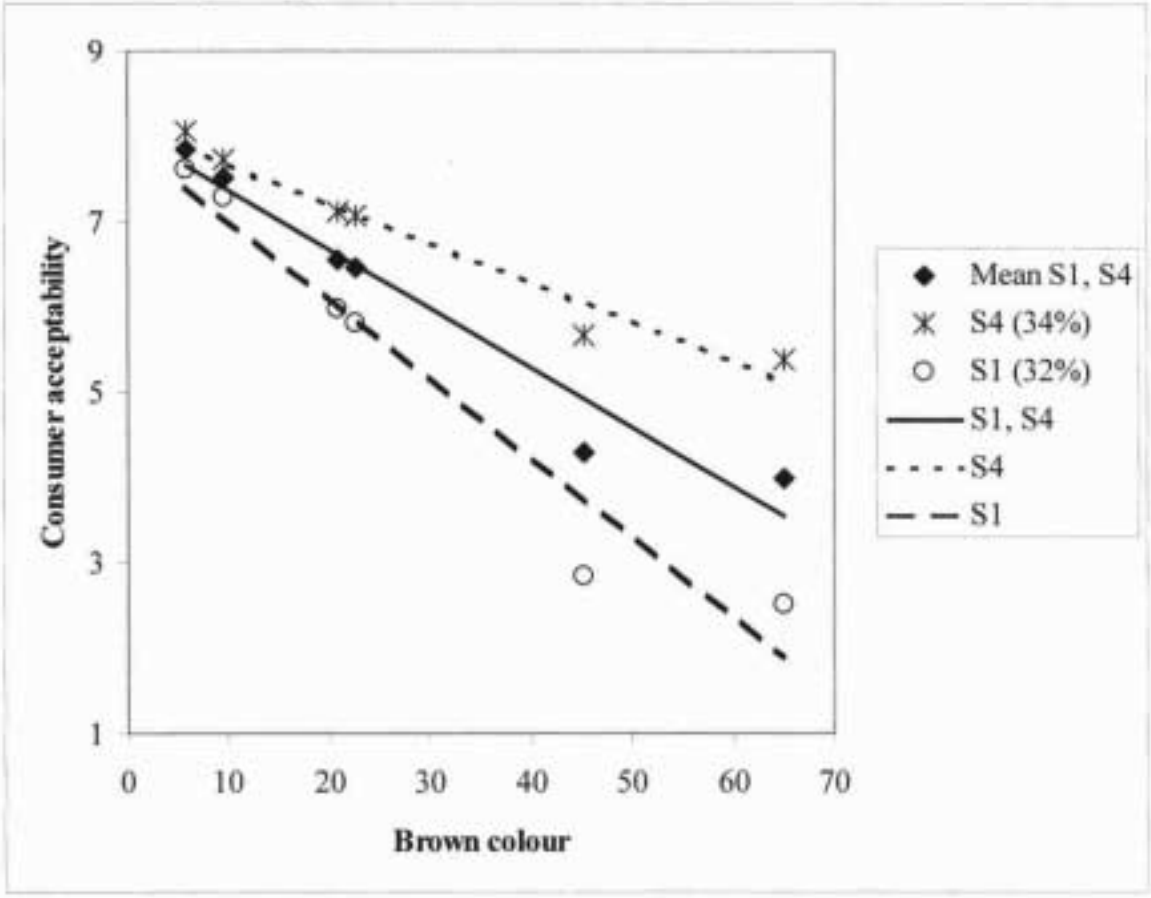
Where: T = Tamale, A = Accra, K = Kumasi, U = Upper East, R = US raw, P = US parboiled; S1, S2, S3 and S4 are consumer segments

b) uncooked sensory attributes and consumer segments



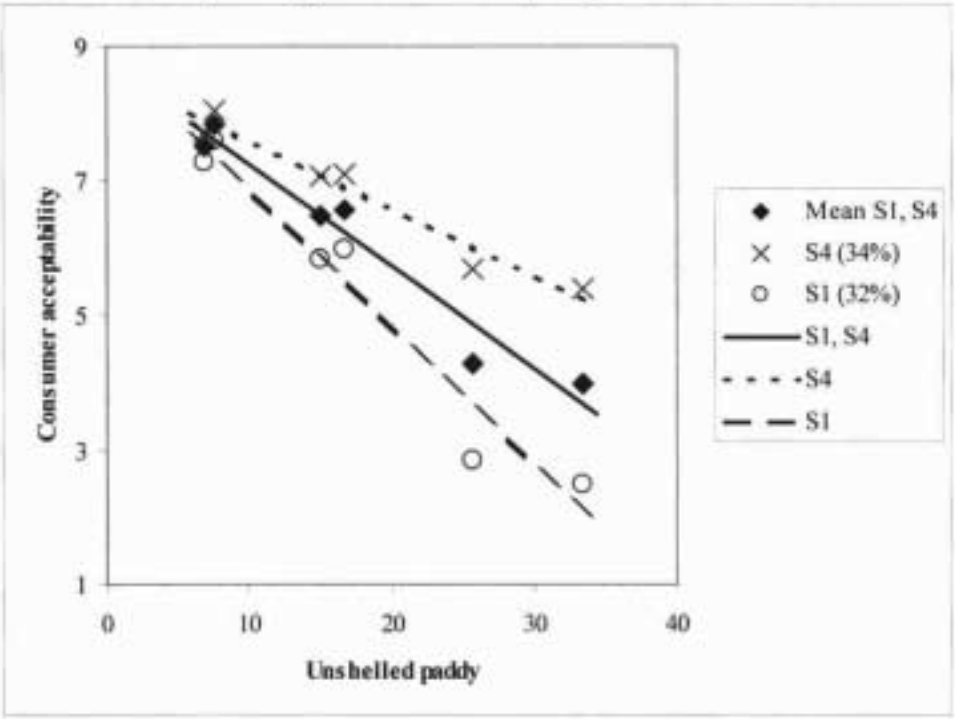
Where: T = Tamale, A = Accra, K = Kumasi, U = Upper East, R = US raw, P = US parboiled; S1, S2, S3 and S4 are consumer segments;
WS = white specks, WGS = whole grain shape

Fig 8
Consumer acceptability and brown colour of cooked rice



Where: S1 and S4 are consumer segments 1 and 4 respectively
Segment 1 acceptability = (-0.0936 x brown score) + 7.967; R^2 = 0.947
Segment 4 acceptability = (-0.0469 x brown score) + 8.154; R^2 = 0.957
Sengment 1+4 acceptability = (-0.0695 x brown score) + 8.063; R^2 = 0.952

Fig 9
Consumer acceptability and unshelled paddy score of uncooked rice



Where: S1 and S4 are consumer segments 1 and 4 respectively
Segment 1 acceptability = (-0.2055 unshelled paddy score) + 8.929; R^2 = 0.950
Segment 4 acceptability = (-0.1026 unshelled paddy score) + 8.631; R^2 = 0.955
Sengment 1+4 acceptability = (-0.1525 unshelled paddy score) + 8.776; R^2 = 0.952