Full Reasearch Article

Preliminary investigation into some quality control indices for selected stored grains in Makurdi, Nigeria

Obetta, S.E.[+] and Daniel, C.
Dept. of Agricultural Engineering University of Agriculture,
Makurdi, Nigeria
*Address for correspondence:- E-mail: sambeta2002@yahoo.com

ABSTRACT

An investigation of some quality control indices of selected grains stored in various locations in Makurdi farming environment was carried out. Grain quality factors are classified into those measurable defects as broken grains, insect damage, mould infestation, presence of foreign materials, and moisture content which determines the storage stability of most grains in the stored structures. Based on the indices mentioned above, an analytical investigation was conducted. An average of 500 gm of grain samples, made up of four (4) crops, eleven (11) varieties resulting in 44 samples and 308 checks in four replications were prepared and quality measures evaluated. Results from these evaluations were compared with the standards of both local and international nature. Results showed that most grains used in Makurdi farming environment did not pass these quality standards. The failure of these tests was attributed to the pre- and post-harvest management practices, such as harvesting, primary processing and the defective storage structures common with producers and vendors of grains in this area.

Key Words: Grain quality, factor indices, primary processing, Storage structures

INTRODUCTION

As indication is showing progress in Governments food production policy, it is auspicious at this period to begin to emphasise on aspects of quality control measures in the production system whose problems would soon emerge. Quality refers to the combination of characteristics that are critical in establishing a products' consumer acceptability (Satin, 1988) and means so little without reference to a particular standard. Once a standard is set, a critical additional component of quality results in a product consistent with adherence to it.

In view of the increasing trade liberalization world wide, majority of countries now emphasize the strengthening of food quality control activities and this informed the necessity of the Federal Government of Nigeria in establishing the National Food and Drug Administration and Control (NAFDAC). This regulatory body provides adequate policy framework for the expansion of food control and other consumer protection services for both domestic and international markets.

Grains/Cereals are the most important sources of the world's total food supply. World grain utilization in 2004 – 2005 is forecast at 1,985mn tonnes, 1.4 percent above the estimated utilization in 2003 – 2004 (FAO, 2004). Feed and industrial usage of coarse grain is likely to grow fastest. A wide variety of them are used as feeds for animals. They are the staple food of people in the developing countries providing them with about 75 % of the total calorific intake and about 67 % of their total protein intake (Nickerson and Louis, 1980). Losses in quality and quantity of grains occur during harvesting, transportation, drying, threshing, processing and most especially in storage (Gwinner *et al*, 1996). Grains from post-harvest activities undergo progressive deterioration to varying degrees in organoleptic properties, nutritional values, safety, and aesthetic appeal (Potter, 1986). Heat, light, cold radiation, oxygen, moisture, dryness, micro-organisms, natural enzymes and contaminants are factors to consider in keeping grains out of deterioration.

These losses are generally encountered because some of the primary post-harvest processing operations are not usually adequately carried out. They include: cleaning, drying, and decorticating, size reduction and many more. Beneath spout line debris associated with grains in storage becomes lodged and continues to accumulate, providing a very congenial habitat and opportunities for the build up of specific insect pests and grain mold fungi (Mabbett, 2004). And the metabolic activity of these insect and microbial populations, combined with the moist materials they are living on, invariably results in 'hot spots' that leads to grain deterioration.

Improper dried grains give up more heat and moisture in storage as they respire resulting to heat buildup, mould formation, insect rapid multiplication and more dangerously the development of aflatoxins and mycotoxins. There has been a wide spread aflatoxin and mycotoxin outbreaks reported (African Farming, 2004) in some parts of the world because of poor post-harvest management and storage of cereals. Aflatoxin and mycotoxin are highly toxic chemicals produced by a variety of mould, contaminated grains, other food and feed ingredients; and finished livestock feed (Mabbett, 2004). They are universally poisonous both to livestock through contaminated feed and to consumers of affected animal products. In humans, the direct consumption of low concentration of these diseases in contaminated grains over a long period of time can be dangerous.

Farm level aflatoxin and mycotoxin prevention strategies and promotion of alternative storage options prior to next harvest should be adopted by using a variety of farm-level drying and storage facilities presented in Lindblad and Druben (1984). Obetta and Onwualu (2001) had also examined various system drier options available to local farmers in a post-harvest technology and made recommendations on the appropriate ones that will best meet their local needs in harnessing harvested grains and other crops. All these efforts are necessary because merchants want dry, insect-free, undamaged grains that will store well. Processors want grain that will yield a high percentage of finished products, while consumers are concerned, in addition to other factors including appearance, cooking and flavour characteristics; nutritious and disease free foods.

In assessing the quality of grains therefore, experts in food technology and food engineering science have the responsibility of securing reliable data so that the local farmers will be better equipped to be properly advised in the following areas: food processing and storage practices that can better preserve the quality of their grains and other food products; identifying key indices that impair quality and inflict losses during harvesting, processing, and handling and storage and educate consumers and local entrepreneurs adequately on the precautions required in post-harvest activities of their grains.

This presentation is aimed at comparing major studied indices of grain quality to known standards. They include broken kernel, insect infestation, mould damage, foreign materials, moisture content and test weight. The study has become necessary to ascertain the food worthiness of some of these grains readily available to unsuspecting consumers and even processors of grains.

MATERIALS AND METHODS

Sampling and Location

Unclean quantity of properly mixed grain samples were randomly drawn at commercial points (markets and ware houses) in North bank location of Makurdi Benue State, Nigeria and other farming locations, with the use of probes and portable milk cans. An average of 500 gm of grains was used as sample for each of the analysis conducted.

Instruments and Equipment

The following instruments and equipment were used for the analysis.

i. Dickey-John digital multi grain moisture meter.
ii. Hectolitre/Test Weight Instrument
iii. Magnifying lens.
iv. Sieves/screens

Crops Analysed

Commercial names of crop grains and their varieties were used and the preference is because the local farmer and general consumers appreciate this instead of the genetic terms.

(i) Maize

(a) White maize (hybrid variety)
(b) Yellow maize
(c) White maize (local variety)
(d) Pop corn

(ii) Sorghum

a. Red sorghum
b. White sorghum

(iii) Beans

(a) White beans (Local variety)
(b) Brown beans
(c) Iron beans
(d) Cameroon beans

(iv) Soybeans

Procedure

An average of 500 g of unclean sample was used for the analysis. The test was replicated three (3) times in each case resulting in a total 308 checks with 44 samples of 4 crops made up of eleven (11) varieties.

The unclean sample drawn was weighed and the different indices were analysed in the following sequence showing how the quantity of all the indices was computed in percentages.

Broken grains

The broken grains were manually picked from the unclean sample after which the remaining samples were weighed. The percentage of broken grains was calculated as given by Hurburgh Jr. *et al* (1989) thus:

$$\% \text{ Broken grains} = \frac{\text{Wt. of unclean sample - Wt. of broken grains}}{\text{Wt. of unclean sample}} \times 100 \qquad (1)$$

Insect infestation

All the grains attacked by insects were removed from the unclean sample. The infested grains were weighed and percentage grain insect infestation computed as in Bengston (1987):

$$\% \text{ Insect infestation} = \frac{\text{Wt. of clean sample - Wt. of infested grains}}{\text{Wt. of clean sample}} \times 100 \qquad (2)$$

Mould damage

The grains damaged as a result of mould activity were separated from the unclean sample, and then weighed. The quantity of grains damaged by mould in percentage was computed thus:

$$\% \text{ Mould damage} = \frac{\text{Wt. of unclean sample - Wt. of moulded grains}}{\text{Wt. of unclean sample}} \times 100 \qquad (3)$$

Foreign materials

All impurities classified as foreign materials were screened out of the unclean sample. The clean samples were weighed and the percentage of foreign materials was calculated as given by Quinn (1987) thus;

$$\% \text{ Foreign materials} = \frac{\text{Wt. of unclean sample - Wt. of clean samples}}{\text{Weight of unclean sample}} \times 100 \quad (4)$$

Test weight

The clean sample free from all impurities (broken grains, mouldy grains, infested grains and foreign materials) was measured using the hectoliter test weight instrument and the equivalent value of grain density obtained from the test weight chart.

Moisture content

The moisture content of the clean grains was taken using the Dickey-John multi-grain moisture meter.

It should be noted that the unclean sample in equations (1) – (4) above was simultaneously screened in the sequence stated before the test weight and moisture contents were conducted.

RESULTS AND DISCUSSION

The results of the grain quality investigations based on the indices studied are presented as follows. Table 1 shows contributions of the quality indices measured for grain samples of hybrid White Maize, Yellow Maize and local White Maize. The indices of major interest in this particular analysis are those of the broken grains, insect infestation, mould damage and presence of foreign materials. The absolute percentage ratio of these qualities to the initial average unclean samples of 522.8 gm is 0.0533 for White Maize; the same percentage ratio for these indices for that of Yellow Maize (with average unclean samples of 520.3 gm) is 0.061 while that ratio for local White Maize to average initial sample of 515.8 gm is 0.11. The individual contributions of these indices compared to the recovered clean grains for hybrid White Maize is as shown in Fig. 1. This trend is similar with other varieties considered and the above figure serves as a representation. The average keeping moisture contents for these crop varieties are 12.23% (wb) for hybrid White Maize; 12.5% (wb) for Yellow Maize; and 12.35% (wb) for local White Maize. The average Test Weight or packing density for hybrid White Maize is 72.6 kg/hl; that for Yellow Maize is 75.9 kg/hl while that of local White Maize is 75 kg/hl.

Similarly, Table 2 shows contributions of the measured quality indices for the grain samples of Popcorn, Red Sorghum and White Sorghum. Popcorn has a total of 2.66% of the quality loss indices in a sample of 511.3 gm and the ratio of the contaminating indices to the clean grains is 0.027 and this is presented as a representative trend for this category of analysis in Fig. 2. Red Sorghum has the ratio of the contaminating indices to the total clean grains as 0.028, while the percentage presence of these indices to the total sample (514.3 gm) handled is 2.73%. In this analysis, White sorghum showed ratio value of contaminating quality loss indices to the clean grains as 0.016 and the presence of these indices in the total sample of 506 gm to be 1.62%.

This trend of analysis is however similar to the results of grain crop types like White Beans/ Brown Beans and Iron Beans found on Table 3.

In addition, similar analysis was obtained for the grains of Cameroon Beans/Soya Beans presented on Table 4. At a glance, Table 5 shows the summary of all the measured quality indices studied.

From Table 5, it was observed that Cameroon beans have the highest percentage contamination of 27.81 followed closely by the local White beans, which has 20.54% while the least contaminated is the white sorghum with 1.62%.

The ratio of contaminated to the uncontaminated vary from the least of 0.016 for White sorghum to the highest of 0.39 for the Cameroon beans and this relationship shows a definite correlation between percentage contamination; and ratio of contaminated to the uncontaminated.

The records of grain analysis indicate that most of the analysed factor indices have not fully met the required standards stipulated for either storage for food strategic and industrial uses, or even considered for exportation. In the summary From Tables 1 – 4, the mean results showed that while some indices barely met the recommended standard, some others failed the quality test standards by significant margins. For instance, the broken grain factor values ranged from 0.14 to 3.03 % compared to the accepted standard of 1 %. The increased values of this factor index may be as a result of breakage that were not controlled during such operations as harvesting, poor handling, threshing methods, shelling and even uncontrolled drying systems.

Insect infestation ranged from 0.59% to as high as 11.63% in bean products, an indication and corroboration that high protein content materials are more susceptible to insect infestations (Bengston, 1987). Further more, this range of values is a suggestion that there are poor control measures against insect pests resulting from cross infestation from neighbouring lots or stores; migration from wastes and defects in storage structures.

Mould damage varied from 1.7 – 12.5%, except for the White and Red Sorghum that were below 1%. This condition is most commonly obtained if grains are not properly dried before sending them to store. It could also be explained by the presence of adverse environmental conditions favourable to moisture absorption and adsorption in the course of jute-bag storage practices found in market stores. If grains are not properly cured after drying, this condition can prevail as a result of condensation and the resulting high humidity build up. The presence of foreign materials was generally low in the grains analysed, with all the samples having an average of less than 1%. This is an indication that grains sampled were reasonably free from foreign materials.

The moisture content status of the sampled grains indicated an average range of 9.5 to 14%, which are within acceptable limits recommended by the Maize Codex Standard (Proctor, 1994). However, some of the values were above the 12% maximum allowable by the Strategic Grain Reserve located in Makurdi (FMA, 2002). The high moisture occurrence in some of the samples tested might be as a result of insufficient drying, high relative humidity, constructional defects in and damage to stores; and imbalances in temperature distribution in the storage facility.

CONCLUSION

Loss of quality may occur during harvesting, transportation, drying, threshing, processing and storage but these losses can be minimized if approved practices and standards are followed. Harvesting at the right time, choice of tolerant varieties, checking infestation before storage, prevention of pest infiltration through the use of sealed structures and regularly performing routine pest control treatments, can control insects and pests infestation.

In as much as maintaining quality of agricultural products for both foods and raw materials in industries is important, a deliberate quality control programme is essential for adding values and improving the agricultural economy of any nation. Wholesome production of finished goods should start with the quality assessment of the raw materials. This exercise became evident in the quality tests conducted in this investigation, which revealed that most of the grains in the study area suffered a lot of quality losses. The implications of this are large. For instance, while the standard for accepting broken grains is 1 %, some studied values of this particular index among crop types were as high as 3.03 %.

The same unacceptable values went for such factor indices as mould damage, insect infestation but the presence of foreign materials was generally within acceptable limits. The findings of this study will enable field workers proffer solutions on how to attain and maintain quality of grains after harvest up to the point of consumption and further processing.

REFERENCES

African Farming and Food Processing. 2004 Assistance for Kenyan Agriculture. No. 44, September 2004. Alain Charles Publishing Ltd, p 5.

Bengston, M. 1987. Integrated Pest Management in Grain Storage Practice. In: Bulk Handling and Storage of Grain in the Humid Tropics. Proceedings of an International workshop. Kualar Lumpur, Malaysia. p. 101 - 108.

FAO, (2004). Food outlook in Brief. Food and Agriculture Organization, Rome. Italy. Http://www.fao.org/giews/english/fo/foto.htm

Federal Ministry of Agriculture. (2002) Acceptance/Rejection Standard. Strategic Grain Reserve Manual.

Gwinner, J.; Harrisch, R. and Mück, O (1996). Manual for Prevention of Post harvest, Grain Losses. Published by Postharvest Project. Http://www.gtz.de/Postharvest/Document/gtz.Html/x0065e00.Htm.

Hurburgh Jr, C.R.; Bern, C J. and Brumm (1989). Efficiency of rotary Grain cleaners in Dry Corn. Transactions of the ASAE 32(6):2073 – 2077.

Lindblad, C. and Druben. L (1980). Small Farm Grain Storage: Preparing Grain for Storage. Vol. I Action/Peace Corps. Programme and Training. Journal No.2, p. 31 – 117.

Lindblad, C. and Druben, L (1980). Small Farm Grain Storage: Enemies of Stored Grains. Vol. II Action/Peace Corps. Programme and Training. Journal No.2, p. 4 – 23.

Lindblad, C. and Druben. L (1980). Small Farm Grain Storage: Preparing Grain for Storage. Vol. III Action/Peace Corps. Programme and Training. Journal No.2 p.17 – 60.

Mabbett, T. (2004). Contamination Control in Feeds. African Farming and Food Processing. No. 42, June 2004. Alain Charles Publishing Ltd. p. 28.

Nickerson, J.T. and Louis. J.R (1980). Elementary Food Science. (second edition). pp. 315 –316. AVI Publishing Company Inc. Westport, Connecticut.

Obetta, S.E. and Onwualu. A.P. 2001. Grain Post-Harvest Technology: Prospect for Profitable Returns from Combined Technical and Marketing Strategy. Journal of Applied Science. 4(2):1845 – 1858.

Potter, N.N. (1986). Food Science. (Fourth edition). pp. 113 – 146. AVI Book Published by Van Nostrand Reinhold New York.

Proctor, D.L. (1994). Grain Storage Techniques; Evaluation and Trends in Developing Countries. FAO Agricultural Service Bulletin No.109. Http://www.FAO.org/Docrep/T1838/T1838EOH.Htm

Quinn, M. (1987). Grain Cleaning – Design and operation overview. In Proc. of 58th *International Technical Conference*, Grain Elevator and Processing Society. Box 15026 Commerce Station, Minneapolis, MN.

Satin, M. (1998). Food Quality and International Trade. Journal of Agricultural and Rural Development. Vol. 5. No. 2.

Table 1: Results of Quality Indices for White Maize (Agric.)/ Yellow Maize/ White Maize (Local Variety)

Crop	unclean weight (g)	broken grains (%)	insect infestation (%)	mould damage (%)	foreign material (%)	moisture content (%)	test weight (kg/Hl)
White Maize (Agric.)							
1	530	1.32	1.91	0.58	0.19	12.8	76.4
2	521	0.19	2.31	2.17	0.40	12.0	71.2
3	515	0.19	3.11	2.00	0.41	12.2	71.6
4	525	0.19	3.05	1.97	0.20	11.9	71.2
Average	522.8	0.47	2.59	1.68	0.30	12.23	72.6
Yellow Maize							
1	545	0.73	1.29	2.25	0.19	13.1	77.2
2	510	0.79	2.57	2.03	0.21	12.1	74.8
3	519	1.35	2.54	2.20	0.20	12.4	75.6
4	507	1.58	3.21	1.45	0.42	12.3	76.0
Average	520.3	1.11	2.40	1.98	0.26	12.23	75.9
White Maize (Local Variety)							
1	521	0.19	9.42	3.18	0.44	11.9	74.0
2	520	0.77	3.29	4.41	0.21	12.3	75.6
3	504	1.59	3.59	4.76	0.22	12.9	75.2
4	518	1.97	3.89	3.45	0.21	12.3	75.2
Average	515.8	0.63	5.05	3.95	0.27	12.35	75.0

Table 2: Results of Quality Indices for Pop Corn/ Red Sorghum/ White Sorghum

Crop	unclean weight (g)	broken grains (%)	insect infestation (%)	mould damage (%)	foreign material (%)	moisture content (%)	test weight (kg/Hl)
Pop Corn							
1	522	0	0.96	0.39	0.39	9.6	82.0
2	503	0.19	0.99	1.41	0.20	9.7	81.2
3	505	0.19	1.39	1.21	0.20	9.2	81.6
4	515	0.19	0.97	1.77	0.20	9.6	81.2
Average	511.3	0.14	1.08	1.19	0.25	9.53	81.5
Red Sorghum							
1	518	0.39	0.58	0.19	0.78	13.1	76.4
2	522	0.19	1.73	0.39	0.78	12.6	77.6
3	515	0.19	1.75	0.39	0.79	12.9	77.2
4	502	0.19	1.59	0.20	0.81	12.5	77.2
Average	514.3	0.24	1.41	0.29	0.79	12.8	77.1
White Sorghum							
1	500	0.20	0.40	0.40	0.81	9.8	74.0
2	509	0.19	0.59	0.19	0.99	12.7	74.4
3	502	0.19	0.59	0.20	0.20	12.8	74.0
4	513	0.19	0.78	0.19	0.39	12.8	74.0
Average	506	0.19	0.59	0.25	0.59	12.03	74.1

Table 3: Results of Quality Indices for White Beans (Local Variety)/ Brown Beans/ Iron Beans

crop	unclean weight (g)	broken grains (%)	insect infestation (%)	mould damage (%)	foreign material (%)	moisture content (%)	test weight (kg/Hl)
White Beans(Local Variety)							
1	540	0.74	2.61	14.56	1.57	12.7	70.4
2	502	0.79	10.64	8.76	0.99	12.8	69.8
3	510	1.76	9.86	9.41	0.49	12.9	69.4
4	506	0.39	9.33	10.50	0.73	12.7	69.8
Average	514.5	0.67	8.11	1.68	0.95	12.78	69.9
Brown Beans							
1	520	0.38	5.02	5.49	1.08	11.9	69.0
2	520	0.38	4.25	11.69	0.99	12.3	69.0
3	510	0.39	3.74	11.86	0.46	12.3	68.6
4	508	0.39	4.15	12.78	0.47	12.4	68.6
Average	514.5	0.39	4.12	1.98	0.73	12.23	68.8
Iron Beans							
1	562	1.78	1.99	3.14	0	12.2	82.0
2	545	2.20	2.06	6.31	0.41	11.7	81.2
3	520	2.31	1.76	5.81	0.21	11.6	82.4
4	522	2.49	3.54	5.29	0.43	11.7	82.0
Average	537.3	2.19	2.34	5.14	0.26	11.8	81.9

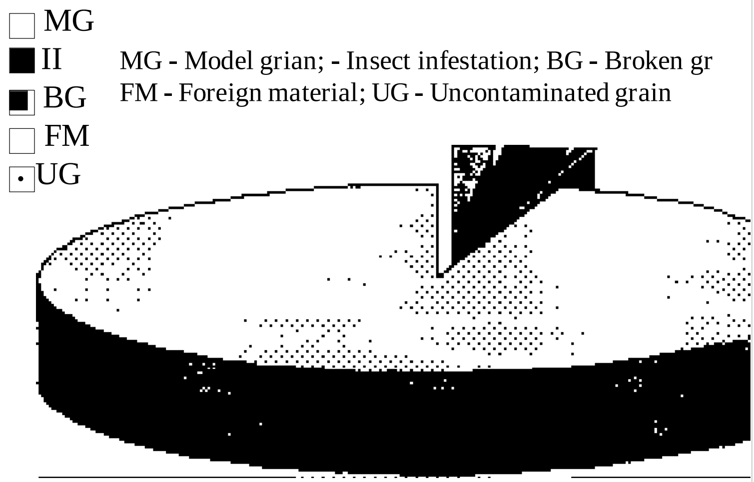
Table 4: Results of Quality Indices for Cameroon Beans/ Soya Beans

crop	**unclean weight (g)**	**broken grains (%)**	**insect infestation (%)**	**mould damage (%)**	**foreign material (%)**	**moisture content (%)**	**test weight (kg/Hl)**
Cameroon Beans							
1	525	1.71	6.20	11.78	1.17	12.2	65.9
2	515	3.30	12.65	14.02	0.27	13.1	63.1
3	507	3.55	14.72	12.95	0.55	13.2	63.5
4	504	3.57	12.96	11.58	0.27	13.2	63.5
Average	512.75	3.03	11.63	12.58	0.57	12.93	64.0
Soya Beans							
1	503	0.19	4.58	3.97	1.52	11.9	72.0
2	519	0	5.39	4.89	0.21	14.0	72.8
3	502	0.19	3.99	5.61	0.22	13.9	72.8
4	506	0.99	6.18	4.47	0.22	14.0	73.2
Average	507.5	0.34	5.04	4.74	0.54	13.45	72.7

Table 5: Summary of the Measured Quality Indices

Grain Type	Sample Studied (g)	Clean Sample (g)	Percentage Contaminated (%)	Ratio of Contaminated to Uncontaminated
White Maize (Hybrid)	522.8	496.36	5.04	0.0533
Yellow Maize	520.3	490.38	5.75	0.061
White Maize (Local)	515.8	464.74	9.90	0.11
Popcorn	511.3	497.70	2.66	0.027
Red Sorghum	514.3	500.30	2.73	0.028
White Sorghum	506	497.90	1.62	0.016
White Beans (Local)	514.3	408.83	20.54	0.26
Brown Beans	514.5	433.71	15.70	0.19
Iron Beans	537.3	483.94	9.93	0.11
Cameroon Beans	512.8	370.16	27.81	0.39
Soya Beans	507.5	453.39	10.66	0.12

MG	1.679999
II	2.589999
BG	0.469999
FM	0.3
UG	94.95999



MG	1.19
II	1.08
BG	0.14
FM	0.25
UG	97.34

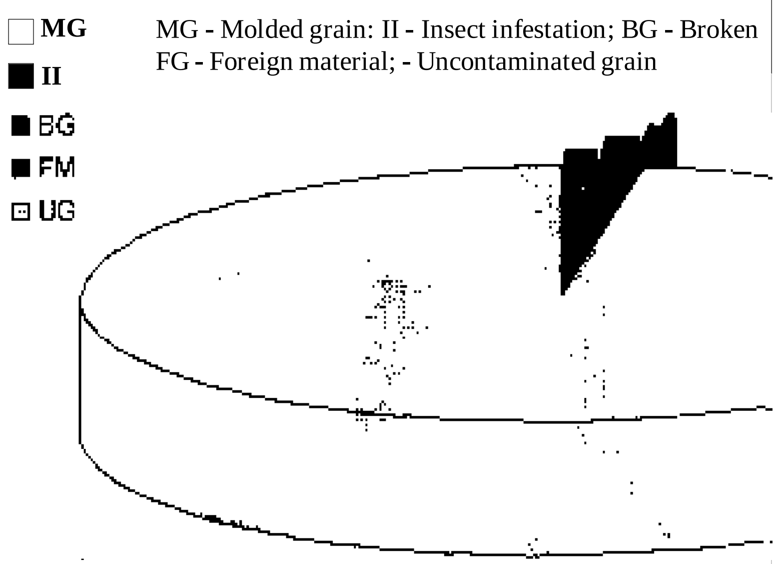


Fig.2: Contribution of Quality Loss Indices compared 1
Grains for Popcorn