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Full Length Research Paper

Proximate composition of selected groundnut varieties and their susceptibility to *Trogoderma granarium* Everts attack

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The proximate composition including moisture content, crude fat, crude protein and ash were determined for six groundnut varieties. Moisture content was highest (8.9%) in SAMNUT 19 followed by SAMNUT 23(8.6%) and was lowest (6.6%) in EX-DAKAR while ash ranged from 3.0% in RRB to 7.4% in RMP-91. The crude protein was highest (31.3%) in EX - DAKAR and lowest (19.7%) in SAMNUT 19. RRB had the highest crude fat of 53.1% while EX-DAKAR had the lowest value of 32.7% showing significant difference ($p < 0.05$) between them. Groundnut variety RRB had the highest percentage kernel damage assessment and kernel weight loss during the storage period. However, these findings may offer scientific basis for *Trogoderma granarium* attack of groundnuts as manifested by nutritional contents of the kernels, percentage kernel damage, percentage weight loss and adult population of the dermestid.

Key words: *Arachis hypogaea*, nutrient composition, *Trogoderma granarium*.

INTRODUCTION

Groundnut, *Arachis hypogaea* L, is an important oil crop of Brazilian origin, is cultivated in tropical and warm temperate climates. The crop is grown usually as a component of a variety of crop mixtures including sorghum, millet, cowpea and maize (Misari et al., 1988). Groundnut is an important oil seed and cash crop accounting for more than one-third of the total oil seed production in India (Sahayaraj and Martin, 2003).

Groundnuts are not only rich in proteins which are easily digestible and consequently, a higher biological value, but are also rich in B-complex vitamins. It is an important item in several confectionery products, and in supplementary feeding programmes such as in weaning food formulations in combination with cereals and pulses in many developing countries. Various cultivars of groundnut tested in Andhra Pradesh, southern India have shown high contents of P and K, possibly due to varietal differences (Pillari et al., 1984). The principal use of groundnut however, is in the production of oil (Cummings, 1986; Elegbede, 1998).

However, production and preservation of this crop is faced by numerous challenges. Since the pods are located underground, the challenge is the absence of suitable implements for harvesting. The curing or drying and storage facilities at the farmers` level also contribute much to the deterioration of seed or kernel quality in storage (Marthur and Jorgensen, 1992). The seeds are prone to quality and quantity losses during storage due to very serious insect pest damage especially Khapra beetle, *Trogoderma granarium* Everts. The insect was discovered in stored guinea corn in Nigeria in 1948 and may have been present in stored groundnuts as early as 1944 (Pasek, 1998). In Nigeria, this insect pest seriously threatens the sustainability of groundnut preservation. Adults *T. granarium* are short-lived and do not feed, but their larvae voraciously feed and cause heavy contamination to the stored product through mass webbing and frass. It will feed on almost any dried plant or animal matter, including dog food, dried orange pulp, bread, and dried coconuts (Szito, 2006). This is particularly distressing for young children, who develop vomiting and diarrhoea, and refuse food (Anonymous, 2001). The aim of the experiment was to determine the

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Table 1. Proximate composition of groundnut varieties.

Variety	Moisture	Crude Fat	Crude Protein	Ash
RMP-12	7.6[a]	47.0[a]	25.6[a]	4.6[a]
RMP-91	7.3[a]	33.7[b]	24.4[a]	7.4[a]
SAMNUT 19	8.9[a]	49.1[a]	19.7[a]	6.5[a]
SAMNUT 23	8.6[a]	47.1[a]	24.9[a]	4.8[a]
EX-DAKAR	6.6[a]	32.7[b]	31.3[a]	5.6[a]
RRB	8.0[a]	53.1[a]	24.5[a]	3.0[a]

Values are expressed as g/100 g samples. Values in the column with different superscript differ significantly at $p < 0.05$.

proximate composition of selected groundnut varieties and severity of attack of *T. granarium* larvae on the groundnuts in three months storage period.

MATERIALS AND METHODS

Insect culture

Fifty adults *T. granarium* (1:1) were obtained from existing culture in the Nigerian Stored Products Research Institute, Ilorin, Nigeria. The insects were maintained on a groundnut variety (RRB) kept in a Kilner jar (250 ml) fitted with wire-mesh cap to allow aeration and prevent entry of other insects. All live and dead insects were removed two weeks after infestation while emerging larvae were used for the experiment. The culture was raised under prevailing temperature (25 ± 3°C) and relative humidity (68 ± 3%) determined by thermohygrograph. This is an instrument used to keep proper records of temperature and relative humidity changes.

Collection and preparation of groundnut varieties

Six improved groundnut varieties used for this study include RMP-12, RMP-91, SAMNUT 19, SAMNUT 23, EX-DAKAR and RRB. They were collected from the Institute for Agricultural Research (IAR), Samaru, Nigeria. The groundnut varieties were air-dried for 4 weeks and then wrapped in separate black polythene bags sealed in a clean dry air-tight container and placed in a deep freezer (-4°C) for 14 days to disinfest the decorticated seeds. The seeds were conditioned on separate plastic trays placed on the laboratory bench for 7 days.

Analysis of groundnut samples

The standard methods of the Association of Official Analytical Chemists (AOAC, 1990) were used to determine moisture, ash, crude fat and crude protein content. Moisture content was obtained by heating three 5.0 g portions of the groundnut samples in an oven (Gallenkamp QC, England) at 110°C until a constant weight was obtained. Ash determination was obtained by the incineration of three 3.0 g samples in a muffle furnace at 600°C for 3 h when a light-grey ash was produced. Crude protein (CP) was obtained using three 3.0 g portions of the samples. The CP was calculated by a multiplying factor (%N × 6.25). The crude fat (CF) was determined by extraction procedure using three 5.0 g samples in a Soxhlet apparatus using petroleum spirit (bp 40 - 60°C) as the solvent.

Determination of damage assessment/weight loss

One hundred grams (100 g) each of the groundnut varieties were weighed in plastic containers (12 cm in diameter) and replicated four times. Five freshly emerged larvae *T. granarium* (about 2 days old) were introduced into each container and then covered with muslin cloth secured with elastic rubber band to allow aeration and prevent entry of other insects or arthropods. An uninfested control of each groundnut variety was included in the experimental set up, laid out in completely randomized design (CRD). The experiment was left undisturbed to allow damage assessment and weight loss calculation at monthly intervals for three months.

Damage assessment involved sieving the groundnut samples using a sieve with a mesh diameter 0.01 mm to remove dust, frass and insects. The samples were then reweighed. Determination of their comparative weights was calculated in terms of the whole sample to give percentage kernel damage.

The percentage kernel weight loss was calculated using the following formula:

$$\frac{\text{Wt. of control kernels} - \text{Wt of infested kernels}}{\text{Wt. of control kernels}} \times 100$$

The total population of adult *T. granarium* in the infested groundnut kernels was recorded after counting with a tally counter.

Data analysis

Data were subjected to analysis of variance and the different means were separated using Student-Newman-Keuls (SNK) test.

RESULTS

The percentage chemical composition of selected groundnut varieties is shown in Table 1. The percentage moisture content ranged from 6.6 - 8.9%. It was highest in SAMNUT 19 followed by SAMNUT 23 (8.6%) and was lowest in EX-DAKAR. The crude fat content of the varieties ranged between 32.7 - 53.1%. Groundnut varieties RRB and EX-DAKAR had the highest and least crude fat content, respectively. There were significant ($p < 0.05$) differences among the varieties for crude fat. The crude protein cont-

Table 2. Groundnut kernel damage assessment following infestation with larvae *T. granarium.*

Variety	Percentage damage assessment (DAI)		
	30	60	90
RMP-12	33.1c	43.7c	41.4b
RMP-91	35.4bc	57.3b	67.4b
SAMNUT 19	37.3abc	61.3b	71.2a
SAMNUT 23	37.5abc	62.3b	80.3a
EX-DAKAR	38.6ab	75.6b	87.0a
RRB	41.4a	91.8a	87.5a
CV (%)	6.5	11.9	14.3
SE(±)	7.6	12.5	16.8

Values in the column with different superscript differ significantly at $p < 0.05$; DAI = Day After Infestation.

Table 3. Groundnut kernel weight loss following infestation with larvae *T. granarium.*

Variety	Percentage kernel weight loss (DAI)		
	30	60	90
RMP-12	24.9abc	31.0a	51.8a
RMP-91	17.4c	27.5a	45.5a
SAMNUT 19	22.7bc	29.0a	49.7a
SAMNUT 23	25.3abc	31.5a	55.0a
EX-DAKAR	29.2ab	34.8a	56.5a
RRB	33.9a	4108a	57.6a
CV (%)	18.8	29.4	14.9
SE(±)	4.82	7.89	9.55

Values in the same column followed by a common letter(s) did not differ significantly at $p = 0.05$ (SNK).

ent ranged between 19.7 - 31.3% for SAMNUT 19 and EX-DAKAR, respectively. The ash content of the different varieties ranged between 3.0 - 7.4%. RMP-91 and RRB had the highest and lowest ash content, respectively. There was no significant difference ($p > 0.05$) among the varieties for moisture, crude protein and ash content.

The groundnut kernel damage assessment following *T. granarium* infestation is shown in Table 2. The varieties differed significantly ($p < 0.05$) in percentage kernel damage assessment. RRB had the highest percentage damage assessment of 41.4, 91.8 and 87.5% at 30, 60 and 90 days after infestation (DAI), respectively. RRB differed significantly from RMP-12 (33.1%) and RMP-91 (35.4%) at 30 DAI. RRB also differed significantly from other varieties at 60 DAI, but it was not significantly different ($p > 0.05$) from SAMNUT 19, SAMNUT 23 and EX-DAKAR during the storage period. RMP-12 had the lowest percentage kernel damage assessment during the study period. However, RMP-12 differed significantly from other varieties at 60 DAI but it was not significantly different from RMP-91 at 90 DAI.

The groundnut kernel weight loss following infestation with larvae *T. granarium* is shown in Table 3. The groundnut varieties differed significantly ($p < 0.05$) at 30 DAI in percentage kernel weight loss. Groundnut variety RRB had the highest percentage kernel weight loss (33.9%) which differed significantly from RMP-91 and SAMNUT 19. Similarly, at 60 and 90 DAI, RRB variety had the highest percentage kernel weight loss; however, the value was not significantly different from other varieties. RMP-91 had the lowest percentage kernel weight loss, but it was not significantly different from SAMNUT 19 and SAMNUT 23 at 30 DAI.

Groundnut variety (SAMNUT 19) had the highest and EX-DAKAR the lowest build up of adult *T. granarium* population at 60 and 90 DAI (Table 4). SAMNUT 19 was not significantly different from RMP- 91. EX-DAKAR was not significantly different from RMP- 12 and SAMNUT 23 at 60 DAI. However, EX-DAKAR was significantly different from other varieties.

Table 4. Comparison of total population of adult *T. granarium* following artificial infestation in stored groundnut.

Variety	Mean adult population(DAI)		
	30	60	90
RMP-12	0	10.0bc	11.2b
RMP-91	0	48.0a	54.6a
SAMNUT 19	0	54.3a	58.4a
SAMNUT 23	0	12.3bc	13.6b
EX-DAKAR	0	4.3c	5.4c
RRB	0	15.0b	16.8b
CV (%)	-	29.6	26.4
SE(±)	-	3.18	3.15

Values in the same column followed by a common letter(s) did not differ significantly at p = 0.05 (SNK).

DISCUSSION

The factors affecting insect infestation of feedstuffs include temperature, moisture, source of insects, available food, air, condition of the feedstuff, presence of other organisms, and the efforts to exclude or kill the pests (Durham, 2008). The nutritive content of groundnut and certain physical properties of feeds such as free water and heat will also determine the vulnerability of such materials to insect attack, especially *T. granarium*. The moisture content ranged between 6.6 - 8.9% in the groundnut varieties studied. The 6.6% moisture content was lower than the safe level required for proper storage reported by Ofuya and Lale (2001). The dermestid beetle attacked the groundnut varieties irrespective of the level of moisture. The beetle can feed on products with as little as 2% moisture content (Pasek, 1998). Moisture content is of importance in storage because the lower the moisture content of food material, the higher the keeping quality (Ajayi and Adedire, 2007).

Feeding by *T. granarium* larvae reduces the weight of kernels in a very short storage period. Feeding activity of the insect pest results in an increase in moisture, crude fat and total protein content (Mason, 2002). In India, loss of weight in groundnut infested by *T. granarium* larvae ranged from 2.2 - 5.5% in wheat (French and Venette, 2005). Previous studies have indicated that severe infestations of grain by Khapra beetle may make it unpalatable or unmarketable. Infestation levels of 75% in wheat, maize, and sorghum grains resulted in significant decreases in crude fat, total carbohydrates, sugars, protein nitrogen, and true protein contents and increases in moisture, crude fibre and total protein (Jood and Kapoor, 1993; Jood et al., 1993, 1996).

The ash content (3 - 7.4%) of the groundnut varieties is to some extent indicative of mineral content (Jossyln, 1973) and it is expected that RMP-91 with highest ash content would have highest mineral content (Abu, 2005). The varieties contained varying degrees of ash content. This is due to the fact that the crop derives its nutrients from the soil.

Crude protein in the groundnut varieties studied ranged from 19.7 - 31.3%. This range compares favourably with the 25 - 30% reported by Metcalfe and Elkins (1980). The results from this study confirmed the observation that groundnut is rich in protein content. This might be attributed to genetic constitution, climatic and varietal differences. The high protein content makes groundnut a good food supplement for man and livestock. The groundnut probably contain protein at a level comparable to that in cowpea (23 - 30%) (Ngoddy and Ihekoronye, 1985).

The varieties had varying degrees of damage by *T. granarium* larvae. The attack of groundnut may be ascribed to the nutritive content, soft kernel coat, and kernel size. The insect attack and infestation on this crop needs to be carefully studied especially on the genetic composition to determine inherent factors responsible for response of *T. granarium* to groundnut varieties. However, storage insect infestation has been reported to be severe on improved varieties than local varieties (Enobakhare and Law-Ogbomo, 2002). Varietal differences exerted significant influence on parameters examined as higher kernel damage and loss were consistently recorded during the period. Despite high preference shown by SAMNUT 19 for adult build-up, it had moderate kernel damage and loss than RRB. Stibick (2007) reported that *T. granarium* is a dirty feeder because it damages more grain than it consumes. If the dermestid is left undisturbed in stored grain it can cause significant weight loss. Weight loss can be between 5 - 30%, sometimes in extreme cases 70% (Dwivedi and Shekhawat, 2004). In this investigation, it was observed that the population of adults was much lower than larvae.

Under optimal conditions, it was found that Khapra beetle can sustain a population increase of between 8.3 times per month. For that reason, population can build-up rapidly in a short time under hot, dry conditions (Ofuya

and Lale, 2001). The larvae feed voraciously, causing heavy contamination to the stored groundnut through mass webbing, exuviae and frass. In an experiment, Mansoor-ul-Hassan et al. (2006) observed a build-up of *T. granarium* at 60 days post treatment. Musa et al. (2009) suggested repeated applications of *Hyptis suaveolens* Poit. seed extracts against *T. granarium* to control the competitiveness of the insect with man for nutritive value of the groundnuts. It is evident that RRB had the highest percentage kernel weight damage and loss during the three months storage period. Infestation of grains by Khapra beetle may present a serious health implication. Cast skins may cause dermatitis in people handling heavily infested grains (Pasek, 1998). Sneezing and eye irritation may be experienced by people handling heavily infested groundnut kernels.

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