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Research Article

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Full Length Research Paper

Storability of soybean flour and its hazard analysis in Nigeria

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Soybean was procured from a local market in Ilorin, washed, dried, milled, packaged and stored under hermetic conditions using transparent plastic container. Proximate composition was carried out on the samples 4-monthly (once-in -4 months) for a period of one year. Moisture content was determined by air-oven method while proximate composition was carried out by Standard Methods of Association of Official Analytical Chemists (AOAC). Moisture contents ranged between 8.0 and 8.9% within one year of storage, while protein levels reduced to 34.9 from 40.4%. Whereas increasing trend was recorded in ash content during the course of storage with ranging values between 4.9 and 5.4%. No definite trend was observed in fibre composition, however, the final value at the end of 12-month storage was found to be 5.8%. Hazard analysis and critical control points (HACCP) procedures were developed and applied for production of high quality as well as safe soybean flour for both local consumption and export.

Key words: Storage, soybean, soy flour, hazard analysis and critical control points (HACCP), hazard, multipurpose dryer.

INTRODUCTION

Oilseeds are one of the most important underutilized raw materials. According to Pyke (1964), about 32% of all edible fats and oils in the world market are largely derived from vegetable sources like cotton seed, groundnut, coconut and soybean. World soybean production in the 2009/2010 harvest was roughly 260 million tons, and the major producers were the United States, Brazil and Argentina, producing 91.4, 69.0 and 57.0 million tons, respectively (USDA, 2011). Given the significant world

production of soybeans, quality is essential for the sectors involved in production and/or processing of this commodity. Quality is an important parameter for commercialization and processing of the grains and can affect the value of the product and its derivatives. Soybean (*Glycine max*) is a legume crop classified as an oilseed and a good source of high quality protein because it contains significant amount of essential amino acids. Its cultivation is becoming more popular with

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farmers in the derived savannah zone of Nigeria and production levels are increasing every year especially now when people are aware of its uses. Good storage management can greatly influence the storability of soybean and subsequent germination when planted in the field as well as other products developed from it. High moisture content and temperature has been reported to increase deterioration and reduce seed viability in storage. Soybean should be stored at a moisture content of 10% or less. At harvest, soybean grains usually contain about 14% moisture. It has been found that soybean can be stored for 6 to 12 months when dried to 13% moisture content, while it can also be stored for longer period when dried to between 10 and 11% moisture content. Open-air drying is the most practical way to protect soybean in storage.

Nutritionally, soybean contains 40.00% crude protein, 19.10% ether extract, 5.71% crude fibre, 5.06% mineral content and 26.05 nitrogen free extract (Oyenuga, 1968). Bates et al. (1977) found that the chemical composition of soybeans changed with the development of the seeds and also reported different chemical composition in vitamins of mature, immature and sprouted vitamins. They found that ascorbic acid and B-carotene decreased with maturity and revealed that the level of B-complex vitamins increased four days after germination, suggesting that sprout could be another nutritious way to consume soybean. The importance of soybean flour in feed formulation and livestock production cannot be overemphasized; this was buttressed by investigations carried out by several authors. Arowora et al. (2004) investigated the utilization of weaner pigs fed soybean and other feed ingredients including biodegraded cassava peel and observed satisfactory growth performance at the end of 8 weeks. Also, Mitaru and Blair (1985) experimented on the comparative effects of dark and yellow rapeseed hulls, soybean hulls and a purified fibre source on growth, feed consumption and digestibility of dietary components in weanling pigs and found that the feed efficiency (gain: feed) values were similar for all dietary treatments with values ranging from 0.53 to 0.57. The market for soybean in Nigeria is growing very fast with opportunities for improving the income of farmers. Currently, SALMA Oil Mills in Kano, Grand Cereals in Jos, ECWA Feeds in Jos, AFCOT Oil Seed Processors, Ngure, Adamawa State, and PS Mandrides in Kano, all these companies process soybean (Dugje et al., 2009).

In the light of aforementioned, therefore, the objective of this study was to investigate the storability of high quality soybean flour produced in Nigeria with the view of making soybean flour available for its various utilization throughout the year at reasonable prices.

MATERIALS AND METHODS

Soybean was procured from a local market in Ilorin, Kwara State, Nigeria. One batch, divided into three samples was used in this

research investigation. The samples were washed and dried using multipurpose dryer (MPD) developed by researchers at Nigerian Stored Products Research Institute (NSPRI). The dried samples were milled and analyzed for proximate composition before packaging in transparent polythene bags with gauge of 0.04 mm and stored under hermetic conditions for one year. Samples were taken for analysis at the end of 4th, 8th and 12th month storage respectively. The three samples were taken as three replicates for analysis. The mean values of 3 replicates with their corresponding standard errors were recorded for analysis. The treatment means of the samples analyzed were subjected to t-test at 5% level of significance using two-tail. Proximate determination of samples was carried out using the standard methods of AOAC (2000). Protein content of *soybean flour* samples was estimated using Microkjeldahl distillation apparatus as per the standard method of AOAC (2000). Crude fat content (triglycerides of fatty acid) of *soyflour* samples was estimated as per the standard method of AOAC (2010) using fat extraction tube of soxhlet apparatus. Ash content was carried out by igniting the sample until only the inorganic residue was left:

$$\text{Ash content} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Crude fibre was determined as that fraction remaining after digestion with standard solutions of sulphuric acid and sodium hydroxide under carefully controlled conditions.

$$\% \text{ crude fibre in sample} = \frac{\text{Mr} - \text{Ma}}{\text{Ms}}$$

Mr = Mass (g) of crucible + dried residue; Ma = Mass (g) of crucible + ash; Ms = Mass (g) of sample taken

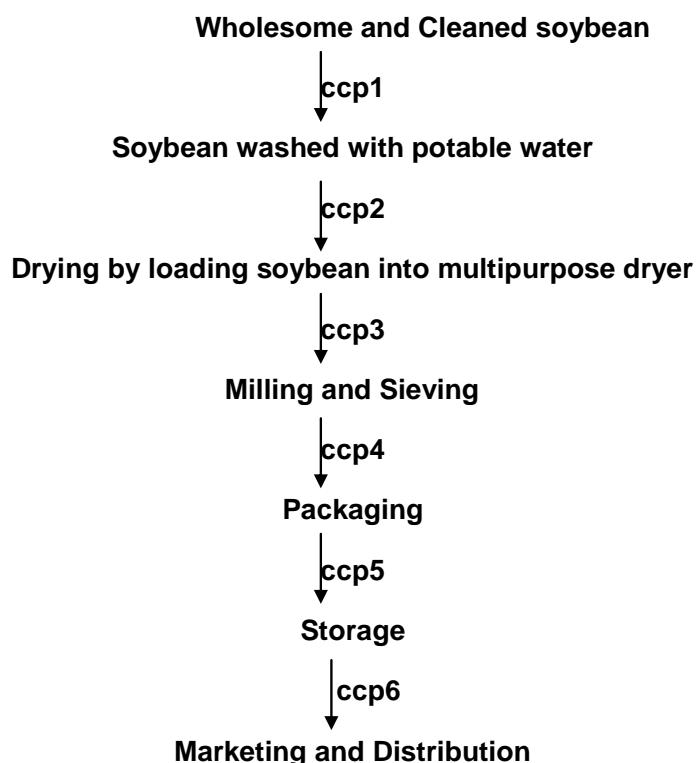
Hazard analysis was developed and applied in the production of safe soybean flour.

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of soybean flour. The results indicated that moisture reduction of samples were still within safe moisture level. Moisture content (MC) represents the amount of extrinsic water in the samples analyzed. There was a decreasing trend in MC values obtained during the course of storage. This decrease was significantly lower ($P < 0.05$) when the final value of treatment mean was compared with the initial of $8.9 \pm 1.0\%$. The decreasing trend observed is similar to the work of Mejule and Lameke (1982) who reported moisture reduction of 0.31% during the course of storage of cocoa beans. Similar result in moisture reduction of 0.30% was obtained by Opadokun and Sowunmi (1985) who worked on storability and quality of maize and sorghum stored in metal silos for four years. Gradual reduction was observed in protein levels during the course of storage. The crude protein of freshly dried soybean flour was found to be $40.4 \pm 0.4\%$, while reduction at the end of 12-month storage was found to be $34.9 \pm 0.1\%$. This decreasing trend was found to be significant ($P < 0.05$). This observation is similar to the results obtained by Opadokun and Sowunmi (1985) who

Table 1. Proximate composition of soybean flour in storage.

Parameters	Mean values (before storage)	Mean values (4-month storage)	Mean values (8-month storage)	Mean values (12-month storage)
Crude protein (%)	40.4±0.4	38.3±0.3	37.3±0.1	34.9±0.1
Crude fibre (%)	5.3±0.1	6.1±0.2	5.6±0.1	5.8±0.1
Ash (%)	4.9±0.1	5.1±0.1	5.3±0.1	5.4±0.1
Ether extract (%)	21.6±1.3	14.6±0.4	13.4±0.8	13.8±0.1
N.F.E. (%)	27.3±0.2	35.8±1.4	38.8±1.6	40.5±1.7
M.C. (%)	8.9±1.0	8.3±0.9	8.2±0.9	8.0±1.0

**Figure 1.** Flow chart for production of soybean flour.

found reduction of 0.3% in the crude protein of maize stored in silos at the end of 12 months. These authors also found reduction of 0.9% in crude protein of sorghum stored in silos at the end of three years.

There was no definite trend in fibre composition in storage. Fibre was observed to range between 5.3 ± 0.1 and $6.1 \pm 0.2\%$ during the course of one year storage. This trend was not significant ($P > 0.05$) when the treatment means of the initial and final fibre content were compared. It was observed that the crude fibre composition of soybean flour sample in this study was higher than that of yellow maize and guinea corn which were found to be between 1.32 and 2.94% respectively (Oyenuga, 1968). The total minerals composition (ash) in this study was found to increase from 4.9 to 5.4% in

storage. However, this increase was not significant ($P > 0.05$) between the initial and final values of minerals content. This was in agreement with the results obtained by Opadokun and Sowunmi (1985) that had range between 2.1 and 3.1% during the course of storage of sorghum in metal silos for one year. Ether extract was found to be decreasing generally during the course of storage. Although the lowest value was obtained from samples stored for 8 months with the value of $13.4 \pm 0.1\%$, it was found that this decrease was significantly lower ($P < 0.05$) when compared the initial and final values of ether extract obtained.

Nitrogen free extract (NFE), this simply refers to the carbohydrate composition of the samples analyzed. There was increase in the trend of NFE values obtained during the course of storage. This increase was significant ($P < 0.05$) when compared the treatment means of initial and final NFE values obtained in storage.

Hazard analysis and critical control points (HACCP) was applied to control and reduce the hazards to acceptable levels thereby producing safe soybean flour for human consumption as follows: Wholesome and clean soybean was procured from a local market in Ilorin and transported to the laboratory using transparent, cleaned and covered plastic, (CCP₁) was uncontaminated soybean (Figure 1). Cleaned soybean samples were washed with potable water in order to eliminate microbial hazard and extraneous materials (CCP₂). Washed soybean samples were loaded into the multipurpose dryer (MPD). At this stage, good handling practices were employed in order to eliminate body contamination and pathogens (CCP₃). The milling of dehydrated soybean was carried out using stainless steel hammer mill and stainless sieves which were sterilized (CCP₄). The soybean flour samples were packaged in food grade polythene which conformed with standard specification with gauge of 0.04 mm. This would eliminate leakage and microbial contamination (CCP₅). The packaged soybean flour were stored under hermetic conditions until sold. This would eliminate moisture migration, caking, mouldiness and mycotoxin contamination during the course of storage (CCP₆). The soybean flour sold to the market were monitored until sold completely. The vehicle used for its transportation was thoroughly cleaned to

avoid contamination.

Conclusion

The results of this study showed that soybean flour produced was highly nutritious and can be stored without adverse effects on its qualities for one year in transparent polythene bags under hermetic conditions. The final protein level of 34.9% is high enough to justify its consumption at the end of one year. Hence it is still safe for local consumption and export within one year of production.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

- AOAC (2000). Association of Official Analytical Chemists. Official Methods of Analysis. 17th Edition, Washington, D.C.
- Arowora KA, Onilude AA, Tewe OO (2004). Performance and nutrient utilization weaner pigs fed different levels of biodegraded cassava-peel based diets, *Trop. Anim. Prod. Invest.* 1:37-44.
- Bates RP, Knapp, FW, Araujo PE (1977). Protein quality of green mature, dry mature and sprouted soybeans. *J. Food Sci.* 42:271-272. <http://dx.doi.org/10.1111/j.1365-2621.1977.tb01269.x>
- Dugje IY, Omoigui LO, Ekeleme F, Bandyopadhyay R, Lava KP Kamara AY (2009). Farmers' guide to soybean production in Northern Nigeria. International Institute of Tropical Agriculture, Ibadan, Nigeria, P. 21.
- Mejule FO, Lameke R (1982). Changes in weight of cocoa during storage. Nigerian Stored Products Research Institute, 19th Annual Report, pp. 137-142.
- Mitaru BN, Blair R (1985). Composition of the effect of dark and yellow rapeseed hulls and a purified fibre source on growth, feed consumption and digestibility of dietary components in starter pigs. *Can. J. Anim. Sci.* 65:231-237. <http://dx.doi.org/10.4141/cjas85-025>
- Opadokun JS, Sowunmi O (1985). Chemical Quality of maize and sorghum stored in nitrogen in metal silos for four years. Nigerian Stored Products Research Institute, 22nd Annual Report, pp. 67-68.
- Oyenuga VA (1968). Nigerian Foods and Feeding stuffs. Their chemistry and nutritive values. Ibadan University Press, 3rd Edition.
- Pyke M (1964). In: Principles of food Science Wikipedia Encyclopedia, <http://www.en.wikipedia.org/wiki/soybean>
- USDA (2011). U.S. soybean inspection March, 14.03.2011, Available from <http://www.usda.gov/oce/commodity/wasde/latest.pdf>

Full Length Research Paper

Eco-friendly approaches for management of bruchid beetle *Callosobruchus chinensis* (Coleoptera: Bruchidae) infesting faba bean and cowpea under laboratory conditions

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Eco-friendly management of bruchid beetle, *Callosobruchus chinensis* infesting faba bean (*Vicia faba*) and cowpea (*Vigna anguliculata*) under laboratory conditions were conducted at Department of Plant Protection, Hamelmalo Agricultural College, Keren, Eritrea, to evaluate the effectiveness of four environment friendly treatments, that is, sesame oil, neem seed powder, hot water salt solution and cold water salt solution were applied to faba bean and cowpea seeds. The lowest percent grain damage by *C. chinensis* was recorded in cold water salt solution for cowpea (18.7%) followed by faba beans (56.7%) compared with control treatments (62.1% in cowpea and 65.3% in faba beans). However, the sesame oil, neem seed powder and hot water salt solution are significantly ($P = 0.05$) affecting damage of bruchid beetle in both, faba bean and cowpea. The maximum percent weight loss was found in control and cold water salt solution in comparison to other treatment.

Key words: Bruchid beetle, faba bean, cowpea, neem seed powder, sesame oil, Eritrea.

INTRODUCTION

Pulse beetle, *Callosobruchus chinensis* L. is one of the most destructive pests of chickpea in storage. Generally, infestation was found in ripened pods from the field, where it is carried to storage and godowns. Specially, cowpea (*Vigna anguliculata*) grains are used for human consumption and green pod as vegetables in Africa (90%) and Nigeria is the world's largest producer of cowpea. It is a serious pest of cowpea in storage often 100% infestation occurs within six months of storage at

the farm level. *C. chinensis* attack the crop when they reach fruiting stage and this seed could be deteriorated (Haines, 1998). The loss caused by this pest to the pulse has been estimated to the tone of 40 to 50% in storage. Bruchids cause a potential loss in legume by feeding on the protein content of the grain and their damage ranges from 12 to 30% in developing countries (Tsedeke and Adhanom, 1985; FAO, 1994). Adult bruchids beetle do not feed and make damage themselves. Female deposit

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eggs on the seeds; and the newly hatched larva bore into the legume seeds and feed inside. The first visible signs are the hole made in the seed by the emerging adult and this is perceived as damage (Koonaa and Koonaa, 2006). The grub causes damage by eating out the entire content of grain leaving only the shell. The damaged seed is unfit for human consumption as well as sowing purpose.

On-farm storage studies in Eritrea showed that staple grains of cereals and pulses produced by small farmers in Eritrea are attacked by different storage pest and the germination loss due to the attack of storage pests on cereals and pulse grains ranges from 3 to 37 and 4 to 88%, respectively (Adugna, 2007). Adugna (2006) investigated that one of the main problems of storage in Eritrea is management of the store and a continuous source of infestation in the stored areas and farmers in most areas keep old and new harvested grains in the same vicinity, which causes an easy migration or infestation of the new grains from the old grains. Farmers in Eritrea use different pest control methods; some are using internationally banned chemicals like DDT, chemicals that leave residue; others use kerosene and some farmers use different traditional methods such as mixing of grain with ash, sand, chilly pepper, and smoke and plant materials (Adugna, 2007). Taking all these into account, there is no any stable method for storing the pulses as it is obvious to say that the grains are base for their life. If we look it also at the national context, it could be a base for the growth of the economy. If a subsistent farmer produces a lot, they can satisfy himself and also for the nation. So, at least to minimize the losses caused by storage pest, it is highly desirable to understand loss caused by storage pest under laboratory that can be used later on guide to extension workers with respect to storage grains.

MATERIALS AND METHODS

Rearing of bruchid beetle

The infested pulses were brought from Keren Grain market to Department of Plant Protection, Hamelmalo Agricultural College for rearing the bruchid beetle in laboratory condition. The bruchid beetle began emerging from the infested stock after 10 days. 50 adults bruchid beetle were transferred into another container in 500 g with fresh faba bean and cowpea. This phenomenon was repeated several times to maintain the culture of bruchid beetle throughout experimental period. The bruchid beetle was used from maintaining culture for entire investigation.

Description of treatments

Four treatments, that is, sesame oil, neem seed powder, hot water salt solution and cold water salt solution were applied on faba bean and cowpea. Uninfested faba bean and cowpea were collected from market and kept 250 g in separate container with three replicate for each treatments. Before storing, five drops of sesame oil admixed on faba bean as well as cowpea. Neem seed powder (at 10 g) mixed with faba bean and cowpea and kept for

observation. Both faba bean and cowpea pulses were dipped in boiled water (500 ml water + 50 g salt) for fifteen minutes and left for sun drying. Similarly, 100 ml of water mixed with 50 g of salt and ad mix with both beans and sun dried for three days. On the other hand, the samples were kept in cold water salt solution with the proportion of 50 g of salt dissolved in 500 ml of cold water for fifteen minutes and were properly dried before storing.

Weight loss assessment

Weight loss assessment percentage was conducted on 250 g of seeds in each container. The damaged grain legumes (grains with characteristic holes) were separated from undamaged portions. The grains in each portion were counted and weighted by using appropriate balance. Petri dish, light bulb and simple microscope were used in experiment. Percent weight loss was calculated using the formula given by Adams (1976) as follows:

$$\% \text{ weight loss} = [(UNd) - (DNu)] / [U(Nd+Nu)] \times 100$$

Where U- the weight of undamaged grains; Nu- the number of undamaged grains; Nd- the number of damaged grains; D- the weight of damaged grains.

Statistical analysis

The data collected by different means were analysed statistically by the application of software Web Agri Stat Package (WASP) developed by Indian Council of Agricultural Research, Goa and significant test by Duncan's Multiple Range Test (DMRT).

RESULTS

Effect of different treatments on bruchid beetle on faba bean

Effect of different treatments, that is, sesame oil, neem seed powder, hot water and cold water were found significantly/non significantly ($P=0.05$) affecting the infestation of bruchid beetle in laboratory condition on faba bean. The result revealed that there was no significant difference among the treatments in the first month (November). The highest percent mean damage was recorded in control (14.33%) and lowest percent damaged grain was recorded in sesame oil (0.33%) during the first month storing (Table 1). There was no significant ($P=0.05$) difference in grain percent damage between control and cold water salt solution treatments with mean of 42.81, 71.3 85.3 99.3 and 37.31, 68.30, 82.3, 96.30% followed by second, third, fourth and fifth months respectively. Similarly there was no significant difference ($P=0.05$) within the treatments sesame oil, neem seed powder, and hot water salt solution treatments across the three months with mean of 0.33, 3.00 and 7.00% respectively.

Effect of different treatments on bruchid beetle on cowpea

Effect of different treatments on cowpea were recorded

Table 1. Percent damage of faba bean by bruchid beetle under laboratory condition.

Treatments/month	1st	2nd	3rd	4th	5th	% damage
Fababean+ Sesame oil	0.33	0.31	0.30	0.48	0.66	0.33 ^b
Fababean + Neem seed powder	2.00	3.15	4.30	3.81	3.33	3.00 ^b
Fababean + Hot water salt solution	2.00	5.50	9.00	9.30	9.60	7.00 ^b
Fababean + Cold water salt solution	6.33	37.31	68.30	82.30	96.30	56.66 ^a
Control (untreated check)	14.33	42.81	71.30	85.30	99.30	65.33 ^a
CD 0.05%						29.45
CV						84.85

Means followed by the same letters are not significantly different ($P=0.05$); DMRT.

and revealed that treatments were significantly/non significantly ($P=0.05$) controlling the infestation of bruchid beetle in laboratory condition. The average percent damage showed that the treatments of sesame oil and neem seed powder significantly affects the infestation of bruchid beetle whereas hot water and cold water was non significant ($P=0.05$) controlling bruchid beetle with each other. However, treatments of sesame oil, neem seed powder and hot water salt solution did significant difference in the first two months. In a similar way, the third, fourth and fifth months storage check treatments of sesame oil, neem seed powder and hot water salt solution did not show significant difference across the months with 0.6, 0.95, 1.3, and 1.6, 2.45, 3.3 and 9.66, 10.3, 10.6 respectively.

However, there was no further damage observed in the fourth and fifth months in cold water salt solution treatment with mean damage of 24.65 and 21 respectively. Control treatment had shown significant difference in the third and fourth months compared to others. Generally, data of cowpea storage under the laboratory condition without treated (control) showed more number of damaged grain followed by cold water salt solution and hot water salt solution treatments with average mean of 59.33, 17.66 and 11.66% respectively.

Percent weight loss of stored grain legume in laboratory condition

The weight of stored legume were significantly ($P=0.05$) decreasing continuously from first month to last month during the study. It could be due to long duration of storage period, building up pest population as a result of increasing number of damaged grains; weight loss goes corresponding to it (Table 3). Overall, the percent weight loss for faba bean was recorded in cold water treatment and hot water salt solution treatment with average mean of 33.8 and 28.00% respectively whereas percent weight loss was found in sesame oil and neem seed powder treatment as 4.67 and 6.80%.

The weight loss of cowpea in storage under laboratory had gone in similar fashion as faba bean. There was no

significant ($P=0.05$) difference among the treatments of sesame oil, neem seed powder, cold and hot water salt solutions with mean of 4.46, 8.36, 25.16 and 24.83% respectively. However, there was significant ($P=0.05$) weight loss in control treatment with mean of 62.80%.

DISCUSSION

The storage of faba bean and cowpea treatment with different physical, neem seed powder and sesame oil were found significantly/non significantly ($P=0.05$) managing the bruchid beetle in laboratory condition. Homan and Yubak (2011) found that botanical materials resulted in significant difference over other treatments in terms of adult mortality, adult emergence, percent grain damage, percent weight loss, moisture content, and germination percent. Among them, *Sesamum* oil, *Cinnamomum camphora* balls and *Acorus calamus* rhizome dust were found to have excellent efficacy in terms of different seeds qualities. The present study is supported with similar finding of Grima (2006) who reported that *Azadirachta indica*, *Melia azadarach*, *Eucalyptus* and *Xanthidium armatum* were not effective in reducing weevil population, moisture content, grain damage and weight loss. The storage of grain legume showed that there were no significant differences among the treatments in first month probably due to pests being at egg stage as a result of very low population with an observed rise in pest population in the second month in some treatments. However there was increasing pest population in an increasing rate in the third and fourth months, which brought up significant difference in grain damage, weight loss and germination among the treatments.

Sesame oil and neem seed powder treated containers had significantly lower insect population than the other treatments in all the study grain legumes. But sesame oil is considered to be the one most effective and all of the treatments used. Sesame oil have medicinal effect on crop which protects the grain when it intermingles with the seed grain managing the storage pest infestation because of its sesamin and sesmalin synergetic property

Table 2. Percent damage of cowpea by bruchid beetle under laboratory condition.

Treatments/month	1st	2nd	3rd	4th	5th	% damage
Cowpea + sesame oil	0.70	0.65	0.60	0.95	1.30	0.84 ^c
Cowpea +Neem seed powder	1.30	1.45	1.60	2.45	3.30	2.02 ^c
Cowpea + Hot water salt solution	6.00	7.83	9.66	10.13	10.60	8.84 ^b
Cowpea + cold water salt solution	3.66	15.98	28.30	24.65	21.00	18.71 ^b
Control(untreated check)	13.66	42.48	71.30	84.8	98.30	62.10 ^a
CD 0.05						20.92
CV						85.55

Means followed by the same letters are not significantly different (P =0.05); DMRT.

Table 3. Weight loss by bruchid beetle on fababean and cowpea.

Treatments/average	% Weight loss	
	Faba bean	Cowpea
sesame oil	4.66 ^c	4.46 ^b
neem seed powder	6.8 ^{bc}	8.36 ^b
hot water salt solution	28 ^{bc}	25.16 ^b
cold water salt solution	33.8 ^{ab}	24.83 ^b
Control	68.33 ^a	62.80 ^b
CD 0.05	34.76	21.93
CV	8.321	65.65

Means followed by the same letters are not significantly different (P =0.05); DMRT.

and he sesame are also oily and slippery in nature. Singh et al. (1994), reported that the vegetable oil is active against eggs and larva and result in inability to oviposit or cause mortality of the adult bruchids as only small amount of oil is needed to preserve the grains for months (1 to 5 ml oil kg⁻¹ of grains). Credland (1992) studied the physical structure of bruchid eggs and suggested that the funnel structure at the posterior pole may be the major route for gaseous exchange and proposed that application of different oil on grain legumes might occlude the funnel, and thus lead to death of the developing insect by asphyxiation. Neem is a botanical with tree presence of active ingredient called Azadarichtin and seed of neem have potential for controlling pest of stored. It has repellent property that can modify the pest behavior and influencing the biological process. Singh and Sharma (2003) tested the efficacy of six different oils, that is, neem (*A. indica*), mehandi (*Lawsonia inetmis* J, castor (*R. cvmmunis*) karanj (*Pvngami pinncata*), mustard (*Brassica juncea*) and olive (*O. Europea*) against pulses beetle and found that among the oils, neem and mehandi oils were effective at 10 ml/kg seeds even beyond 150 days after treatment and the rest of the oils reverse effective even after 280 days of oil treatment, and also germination test result carried out with the oil treated seeds at 4 different time intervals (6 to 8 h, 90, 150 and

210 days after treatment) revealed significant difference among the treatments and untreated control. Tripathy et al. (2001) studied the efficacy of different vegetable oils (castor, neem, pongamia coconut, mustard, sesame, soybean and sunflower) and found that oil treatments were superior in protecting the seeds from Pulses beetle attack than malathion treatment or control and the oils of neem, castor and coconut at both the doses plowed most effective in protecting the seeds for about 9 months after treatment. Singal and Chauhan (1997) tested the effect of some plant products and other materials on the development of pulses beetle attacking stored grains.

Neem seed oil and neem seed kernel powder individually prevented egg-laying for up to 8 months of storage and a negligible adult population developed after this period. Hot water and cold water salt solution are physical treatments used in the grain legumes of the present study. Cold water salt solution inhibits egg laying of adult bruchid with presence of acidic in property. In case of hot water salt solution, the hot water kills the internal seed infection which already occurred before application of treatments and the salt solution are inhibiting oviposition of bruchid beetle.

Conclusion

Legume grains, that is, faba bean and cowpea treatment with physical (cold water and hot water with salt), neem seed powder and sesame oil revealed that the different treatments significantly reduced the infestation of bruchid beetle from the first month to fifth month study. All in all it can be concluded that the severity of grain legumes damage by the insect pest increase across the successive months which resulted in a significant percent weight loss in all the grains studied. The most effective treatments was found to be sesame oil at 5 drops, Neem seed powder at 10 g and hot water salt solution at 50 g each in 250 g grains.

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

- Adams JM (1976). A guide to the objective and reliable estimation of food losses in the small scale farmer storage Trop. Stored Prod. 32:5-12.
- A dugna H (2006). On-farm storage studies on Sorghum and Chickpea in Eritrea. Afr. J. Biotechnol. 5:1537-1544.
- A dugna H (2007). Wheat grain on-farm storage studies in Eritrea. African Crop Sci. Confer. Proceed. 8:1917-1921.
- Credland P (1992). The structure of bruchid eggs may explain the ovicidal effect of oils. J. Stored. Prod. Prot. 28(1):1-9.
- FAO (1994). Grain storage techniques, evaluation and trends in developing countries. FAO Agricultural service bulletin, Rome, Italy pp. 1-109.
- Haines C (1982). Pest management in stored products. Prot. Ecol. 4:321-330.
- Homan R, Yubak Dhoj GC (2011). Eco-friendly management of pulse beetle The J. Agric. Environ.12:1-10.
- Grima D (2006). Field infestation by *Sithpillus zeamais* Mostch. (Coleopteran: Curculionidae) and its management on stored maize at Bako western Ethiopia. M.Sc. Thesis presented to school graduate studies, University. pp. 3-8.
- Koona P, Koona OES (2006). Testing fractionated extracts gained from the Ethiopian botanical *Pachypodanthinum staudtii* (Annoaceae) for bruchid insect control (Coleoptera: Bruchidae). Res. J. Agric. Bio. Sci. 2(6):410-414.
- Singal SK, Chauhan R (1997). Effect of some plant products and other materials on the development of pulse beetle, *Callosobruchus chinensis* (L.) on stored pigeon pea. J. Insect Sci. 10: 196-197.
- Singh VN, Pandey ND, Singh YP (1994). Effectiveness of vegetable oils on the development of *Callosobruchus chinensis* L. infesting stored grain. Indian J. Entomol. 56(3):216-219.
- Singh S, Sharma G (2003). Efficacy of different oils against *Callosobruchus chinensis* in green gram and their effect on seed germination. Indian J. Entomol. 65(4):281-286.
- Tripathy MKP, Sahoo BC, Das, Mohanty S (2001). Efficacy of botanical oils, plant powders and extracts against *Callosobruchus chinensis* Linn. attacking blackgram. Legume Res. 24(2):82-86.
- Tsedeker A, Adhanom N (1985). Current state of stored product management research. In: (Tsedeker Abate ed.) A Review of Crop Protection Research in Ethiopia: Proceedings of the First Ethiopian Crop Protection Symposium, 4-7 Feb, pp. 645-652.



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