Influence of Biopesticides on the Nutrient Content of Stored Cowpea (*Vigna unguiculata*) in Yola, Adamawa State, Nigeria

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ABSTRACT

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The influence of biopesticides on the nutrient content of stored cowpea grains was investigated to determine the effect of these plant extracts on the proximate composition. The treatments consisted of cowpea grains treated with pure and mixtures of castor oil, cashew oil, lemon balm, and scent leaf powders applied at different rates. The experiment was laid out in a completely randomized design (CRD) with 18 treatments replicated three times and stored for 120 days. The result showed a highly significant effect of the botanicals on the proximate content of the grains. Cowpeas treated with 10 g scent leaf powder (SLP) had the highest moisture content (12.11%), 15 g SLP-treated grains also recorded the highest ash and crude protein content (7.22 and 39.39%, respectively) and cowpea treated with 20 g SLP showed the highest crude fat (6.80%). In terms of crude fibers, samples treated 15 g lemon balm powder (LBP) reported the highest content (5.43%) and grains treated with 20 g LBP sample produced the highest dry matter content (90.22%). Both pure and mixtures of castor and cashew oil treated samples recorded the highest carbohydrates (66.98-66.79%) whereas the highest calorific value occurred with samples subjected to 2 ml of castor oil (372.31kcal/g).

Keywords: Biopesticides, *Callosobruchus maculatus*, cashew oil, castor oil, cowpea, lemon balm powder, scent leaf powder, *Vigna unguiculata*

Cowpea (*Vigna unguiculata* (L.) Walp) is the most produced legume in West Africa and other tropical countries. The crop is cultivated intentionally for food, fodder, and green manure; its production has expanded worldwide over the past few decades (Gusmao et al. 2013, Mkenda and Ndakidemi 2014, Sanon et al. 2018). In 2017, over 87% of the crop was produced in Africa. Cowpea is of vital importance to the livelihoods of millions of people in the semi-arid regions of West and Central Africa, and is a major source of plant proteins. It is the most valuable grain legume crop in sub-Saharan Africa and Brazil (Gusmao et al. 2013, Langyintou et al. 2003, Swamy et al. 2020). Due to its high protein and low-fat content, it is grown mainly for human consumption (Gerrano et al. 2017), it also aids in the prevention of diverse metabolic

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and cardiovascular diseases. The whole above-ground cowpea plant is a multipurpose crop being consumed for its leaves, green pods, green beans, and matured beans, or processed into paste or flour and used as food ingredients (Xu and Chang 2012). The cowpea is also utilized as fodder, fertilizer, and as a quick-growing cover crop and plays a particularly critical role in erosion control and feeding animals during the dry season.

One of the major challenges facing the production of cowpea is the pest attack by cowpea weevil, which infests cowpea pods from the field to the store, causing highly significant postharvest losses (Sanon et al. 2018). According to Mkenda and Ndakidemi (2014), 30-80% of cowpea, equivalent to US$300 million is lost to bruchid (*Callosobruchus maculatus*) attacks annually in Africa. Cowpea weevils include weight, nutritional, economic, sensory, and seed viability losses (Gusmao et al. 2013, Mkenda and Ndakidemi 2014, Sanon et al. 2018).

Botanical pesticides have recently attracted more attention due to the drawbacks related to chemical pesticides and widespread concern for human health, food safety, and environmental aspects such as environmental pollution, killing of beneficial and non-target fauna and flora, pest resistance, pest resurgence, and human toxicity due to chemical residue accumulation in the treated grains (Anukiruthika et al. 2021, El-Sharkawy et al. 2023, Gusmao et al. 2013, Mkenda and Ndakidemi 2014, Sanon et al. 2018, Swamy et al. 2020).

These botanical pesticides contain active compounds like monoterpenes, diterpenes, sesquiterpenes, myrcene, carvone, piperitenone, linalool, alkaloids, saponins, tannins low molecular weight aromatic compounds, volatile compounds, secondary metabolites, flavioboids, phenols, rotenoids, etc (Gusmao et al. 2013, Mkenda and Ndakidemi 2014, Sanon et al. 2018) whose effect on nutrient content of the processed products is not yet ascertained. There is an urgent need to understand the effect of these compounds on the nutrient content of treated grains for a wider application in the postharvest management of cowpea weevil. There is also a dearth of information on the effect of castor, cashew oil, lemon balm, and scent leaf powders on the effect of these products on proximate composition of cowpea. It is against this backdrop that this research is designed to investigate the influence of these botanical pesticides on the proximate composition of the cowpea grains after storage.

MATERIALS AND METHODS

Experimental site.

The experiments were conducted in the laboratory (Yola, Nigeria), in 2020 to test the effect of plant products on the sensory quality of the cowpea grains after storage. The study was conducted from March to June 2020. The daily storage temperature and relative humidity were 34-35ºC and 30 34%, respectively.

Materials used.

The materials used for this study are: cowpea (*V. unguiculata*) grains, castor (*Ricinus communis*) oil, cashew (*Anacardium occidentale*) oil, scent leaf (*Ocimum gratissimum*) powder, and lemon balm (*Melissa officinalis*) powder, 10-micrometer mesh muslin cloth, sieve, digital weighing balance, hand lens, conical flask, glass jar, Petri dishes, digestive flask, electric oven, heat mantle, and crucible plate. The cowpea sample (black-eyed peas) used for the study was purchased directly from a farmer in Mubi Local Government Area of Adamawa State. Cashew oil was extracted using a local method of extraction. Castor oil was purchased from an authorized Pharmacy dealer in Jimeta, while Cashew oil was extracted manually using the traditional method of oil extraction. Scent leaves were obtained directly from the vegetable garden in Girei Local Government Area of Adamawa State, while lemon balm was obtained from fields within Modibbo Adama University, Yola.

Sample preparation.

Cowpea grains were disinfested using the electric oven at 60 °C for 3 hours and packed in a 12 kg air-tight bag to prevent cross-contamination by other insect pests and stored in the laboratory for subsequent use. Then the cowpea grains were thoroughly cleaned, sieved, and placed in round-bottom flasks for treatment.

Both scent leaf and lemon balm powders were prepared by shade drying, grinding, and sieving until a fine powder was obtained.

Application of test materials.

The botanicals (oils and leaf powders) were poured into a conical flask containing the cowpea grains and mixed vigorously to obtain uniform coverage and then transferred into the jars according to the method of Ilesanmi and Gungula (2010), and Shikaan and Uvah (2002).

rearing procedure for experimental insects (*C. maculatus*).

The bruchid insects (*Callosobruchus maculatus* (Fabricius)) used were obtained from infested cowpea grains from the produce market in Jimeta, Yola, placed inside a plastic container containing 1 kg of uninfested cowpea grains and covered with 10 µm mesh muslin cloth to allow free air circulation and also to prevent the insects from escaping. The plastic containers were kept in the laboratory for five weeks at ambient conditions. After rearing, both adult and dead bruchids were removed from the plastic containers to allow for successful hatching of the eggs. Newly hatched bruchids (1 to 3 days old) were then collected and used to infest the experimental cowpea grains.

Treatments and experimental design.

The cowpea grains were treated with (i) Castor oil, (ii) Cashew oil, (iii) Scent leaf powder, and (iv) Lemon balm powder at different concentrations. Two hundred grams of cowpea were weighed into nineteen (19) glass jars. Treatments T1-T6 consisted of cowpea grains treated with three different concentrations of castor and cashew oils (1, 2, and 3 ml/200 g) each. The mixture of castor and cashew oils in the ratio of 1:1, 1:2, and 2:1 were used to treat cowpea grains labelled as treatments T7-T9. Cowpea grains treated with three different concentrations of scent leaf and lemon balm (10, 15, and 20 g/200 g) each were placed under treatments T10-T15. Similarly, scent leaf and lemon balm powder ratios of 1:1, 1:2, and 2:1 were used to treat cowpea grains under treatment T16-T18. The control was left untreated.

Each glass jar housed 20 unsexed 1-3 days old weevils together with cowpea grains and covered with 10 µm mesh muslin cloth. Each treatment was replicated three times and laid out in a Completely Randomised Design (CRD). All the treated cowpea grains were kept at the ambient condition in the laboratory. At the end of the storage periods (120 days), data were collected on the proximate composition of the cowpea grains.

Laboratory analysis.

Determination of proximate composition. Proximate composition was determined according to the method of the AOAC (2020) protocol reported by

Ahmed et al. (2023) to determine crude fat, moisture, ash crude fibers, proteins, and carbohydrates of both treated and untreated cowpeas.

Determination of moisture content. Five grams from each sample were weighed into a pre-weighed aluminum drying dish. The samples were dried to a constant weight in an oven at 105ºC for four (4) hours. The moisture content was then determined using equation 1:

$$Moisture\ content = \frac{M1 - M2}{M1 - M0}\ x\ 100,$$

where M_o = Weight of aluminum dish, M_1 = Weight of free sample + dish, and M_2 = Weight of dry sample dish.

Determination of dry matter. Dry matter was determined by using equation 2:

$$\text{Dry matter} = 100 - \text{moisture content}.$$

Determination of ash content. Five grams of each sample were weighed into a porcelain crucible. Organic matter was charred by igniting the material on a hot plate in the fume cupboard. The crucible was then placed in the muffle furnace (ECF3 Chesterfield, UK) and maintained at 550ºC for 6 h. It was then cooled in a desiccator and was weighed out on a digital weighing balance. Rate ash was determined using equation 3:

$$\text{Ash (\%)} = \frac{\text{(weight of crucible with sample)} - \text{(weight of empty crucible)}}{\text{Sample weight}}\ x\ 100.$$

Determination of crude protein content. For the determination of crude proteins, a Kjedahl nitrogen method was used. One gram of the sample from each treatment was introduced into an 800 mL digestion flask. Kjedahl catalyst (5 selenium tablets) was added to the sample. Twenty milliliters of concentrated sulfuric acid was added to each sample and fixed to the digestion flask until a clear solution was obtained.

The cooling digest was transferred into a 100 ml volumetric flask and was made up to the mark with distilled water. The distillation apparatus was set up and rinsed for 10 min. After boiling, 20 ml of 4% boric acid was pipetted into conical flasks, drops of methyl red were added to each flask as an indicator, and the digest was diluted with 75 ml of distilled water. Ten milliliters of the digest were made alkaline with 20 ml of 20% NaOH and distilled. The steam exit of the distillatory was closed and the color of the boric acid solution changes to green. The mixture was distilled for 15 min and boric acid along with distillate was then titrated against 0.1 N hydrochloric acid. The percentage total nitrogen was calculated as indicated in equation 4:

$$\text{Total Nitrogen (\%)} = [(\text{Titer x Normality x } 0.014) / \text{ Weight of sample}]\ \text{x}\ 100,$$

where Normality = 0.1N, Crude proteins (%) = Total nitrogen x 6.25 (%) [6.25 is a constant].

Determination of fat content. Five grams of the sample were weighed in a thimble and plugged with cotton wool. The thimble was then inserted into a Soxhlet system. A previously weighed clean, dried 250 ml flask was filled with 200 ml of petroleum ether (boiling point 40-60°C). The Soxhlet apparatus was assembled and allowed to reflux for about 6 h. At the end of 6 h, the solvent was recovered and the flask with the extract was dried in the oven (DHG-9023A, England) at 105°C for 30 min. It was then cooled in the desiccator and weighed and determined using equation 5:

$$fat\ (\%) = \frac{\text{W3} - \text{W2}}{\text{W1}}\ x\ 100,$$

where, W_1 = weight of sample, W_2 = weight of empty flask, W_3 = weight of flask extracted oil.

Determination of crude fiber content. The defatted sample (2 g) was placed in a 500 ml conical flask, and 150 ml boiling 1.25 % sulfuric acid solution was added. The sample was digested for 30 min, and then the acid was drained out and the sample was washed with boiling distilled water. After this, 1.25 % sodium hydroxide solution (150 ml) was added. The sample was then digested for 30 min; thereafter, the sodium hydroxide solution was drained out, and the sample was then washed with boiling distilled water. Finally, the sample was placed in a dried crucible and oven-dried at 110°C overnight. The sample was allowed to cool in a desiccator and then weighed (W_1). The sample was ashed at 550°C in a muffle furnace for 2 ho, cooled in a desiccator, and reweighed (W_2). The extracted fiber content was expressed as a percentage of the original understated sample and calculated by equation 6:

$$Crude\ fibre(\%) = \frac{\mathrm{Wi} - \mathrm{W2}}{\mathrm{Wo}} x100,$$

where W_1 = Digested sample, W_2 = Ashed sample, W_0 = Weight of sample.

Determination of carbohydrate content. Carbohydrates were calculated by subtracting the sum of the percentage of moisture from 100 as described by Egan et al. (1981) in equation 7:

$$\text{Carbohydrates} = 100 - [\text{moisture (\%)} + \text{proteins (\%)} + \text{ash (\%)} + \text{fat (\%)} + \text{crude fibers (\%)}].$$

Energy content. The energy content was estimated following the method employed by Emmanuel and Folasade (2011) by applying equation 8:

$$\text{Energy (Kcal/100 g)} = (\text{Crude lipid } x\ 8) + (\text{Crude proteins } x\ 2) + (\text{Carbohydrates } x\ 4).$$

Data analysis.

All the data collected were subjected to Analysis of Variance (ANOVA) appropriate for Completely Randomized Design (CRD), using Genstat statistical software Discovery Edition, and the means were separated using the Duncan Multiple Range Test (DMRT) at a 5% level of probability.

RESULTS

Moisture content.

There were highly significant differences ($p \leq 0.01$) among the various treatments (Table 1). The highest moisture content was observed in samples treated with 10 g Scent Leaf Powder (SLP), with a mean value of 12.11% and the lowest moisture content was observed in samples treated with 20 g Lemon Balm Powder (LBP), with a mean value of 9.78%.

Dry matter content. Samples treated with 20 g LBP had the highest dry matter content (90.22%) due to the highly significant differences ($p \leq 0.01$) caused by the treatments as depicted in Table 1, This is followed by 2:1 SLP / LBP, 1:1 castor (CT)/cashew (CS) oils and 1:1 SLP/LBP with their respective mean values of 89.78%, 89.56% and 89.55%. The least was observed in 10 g SLP samples with a mean value of 87.56%.

Ash content. The result of the ash content showed highly significant differences ($p \leq 0.01$) between the treated and untreated samples (Table 1). The highest ash content was recorded on samples treated with 10 and 15 g SLP, which had mean values of 7.55% and 7.22% respectively, followed by 1:1 SLP/LBP (7.00%), and the least mean values were observed in castor and cashew oils as presented in Table 1. There were no significant differences between 2 ml castor oil, 3 ml cashew oil, and 2:1 CT/CS oils as they had the same mean values of 2.33% each.

Crude proteins. The result showed a highly significant effect ($p \leq$

0.01) of the biopesticides on cowpea grain's crude protein content (Table 1). Cowpea grains treated with 15 g LBP were observed to have the highest mean crude proteins (39.39%). Followed by control with a mean value of 34.14% and then 10 g scent leaf powder samples with a mean value of 33.55%, the least was observed in the sample treated with 3 ml cashew oil, with a mean value of 15.47% and 1 ml castor oil with the value of 15.04%.

Fat content. The results in Table 1 showed that there were highly significant differences ($p \leq 0.01$) in fat content among the various treatments. Cowpea treated with 20 g scent leaf powder sample recorded the highest fat content with a mean value of 6.66% while 1 ml and 1:2 castor/cashew oils recorded the lowest fat content with a mean value of 2.86% and 2.86%, respectively.

Crude fibers. The results of the effect of biopesticides on crude fibers were highly significant ($p \leq 0.01$) as presented in Table 1. Cowpea treated with 15 g LBP was presented to have the highest crude fibers as compared with the other treated and untreated samples, with a mean value of 5.43% while 2 ml CT and 3 ml CS oils recorded the lowest fiber content with the mean value of 2.13% and 1.917%, respectively.

Percentage carbohydrate content. The percentage carbohydrate content of cowpea samples was influenced in a highly significant ($p \leq 0.01$) way, as presented in Table 1. The results showed that there were differences among the various treatments. It was observed that 2 ml CT oil-treated samples had the highest percentage carbohydrate content with a mean value of 66.79% followed by 3 ml CS oil-treated samples with a mean value of 65.77%, and the least was observed in 15 g LBP-treated samples with a mean value of 34.18%.

Calorific value. The energy value of the cowpea sample presented in Table 1 showed that there were highly significant differences ($p \leq 0.01$) among the various treatments in terms of calorific value. The results showed that 2 ml CT oil had the highest energy value with a mean value of 372.31 Kcal/g, followed by 3 ml CS oil and 2:1 CT/CS oils with their respective mean value of 370.50 and 368.03 Kcal/g. Whereas the least was observed in the 10 g LBP sample with a mean value of 344.03 and the 1:1 SLP/LBP sample with a mean value of 348.35 Kcal/g.

DISCUSSION

Treatment of cowpea grains with SLP increases moisture content due to the absorption of moisture from the storage atmosphere caused by increased insect population and metabolism. The moisture content of these analyzed samples is within the United States Storage Recommendation Standard of 8 to 12% recommended for long-term storage. The moisture content recorded in this study is in tandem with that of other researchers (Davis et al. 1991, Illesami and Gungula 2016, Singh 2014, Therese et al. 2019).

The application of 20 g LBP assisted in conserving dry matter content after storage and the values reported in this work agreed with those of Adino et al. (2018) and Agele et al. (2017). They observed that the variations in moisture content can be the sources of differences in the dry matter production and partitioning as a result of the effect of some biopesticides.

Table 1. Proximate composition and calorific value of cowpea treated with biopesticides

Treatment	Moist. Cont.	Dry Mat.	Ash Cont.	Crude Prot.	Fat Cont.	Crude Fibers	Carbohy.	Energy Kcal/g
1 ml CT	10.44^{cd}	89.56^{ab}	3.333^{c}	18.82^{fg}	3.787^{efg}	2.597^{gh}	61.02^{a}	366.89^{abc}
2 ml CT	10.33^{cd}	89.67^{ab}	2.333^{c}	15.04^{g}	3.243^{fg}	1.917^{h}	66.79^{a}	372.31^{a}
3 ml CT	10.22^{cd}	89.78^{ab}	2.667^{c}	19.76^{fg}	3.453^{fg}	2.923^{efg}	60.98^{a}	359.88^{ad}
1 ml CS	11.33^{abc}	88.67^{bcd}	5.110^{b}	24.15^{de}	4.343^{def}	3.330^{def}	52.14^{b}	358.67^{bcd}
2 ml CS	10.45^{bcd}	89.30^{ab}	2.667^{c}	20.26^{ef}	2.863^{f}	2.790^{fgh}	60.89^{a}	364.16^{abc}
3 ml CS	10.67^{bcd}	89.33^{abc}	2.333^{c}	15.47^{g}	3.633^{og}	2.130^{h}	65.77^{a}	370.50^{ab}
10 g SLP	12.11^{a}	87.56^{d}	5.777^{ab}	25.38^{de}	5.413^{bcd}	3.450^{de}	47.46^{bcd}	354.78^{cde}
15 g SLP	11.78^{ab}	88.22^{cd}	7.223^{a}	26.83^{cd}	6.073^{ab}	3.697^{cd}	44.40^{cde}	354.64^{cde}
20 g SLP	11.22^{abc}	88.78^{bcd}	6.330^{ab}	24.38^{de}	6.797^{a}	3.347^{def}	47.92^{bc}	365.38^{bc}
10 g LBP	11.11^{abc}	88.89^{bc}	7.553^{a}	33.55^{b}	4.780^{cde}	4.633^{b}	37.71^{fg}	344.03^{e}
15 g LBP	10.33^{cd}	89.67^{ab}	5.890^{ab}	39.39^{a}	4.777^{cde}	5.430^{a}	34.18^{g}	354.66^{cde}
20 g LBP	9.78^{d}	90.22^{a}	6.663^{ab}	32.09^{b}	5.827^{abc}	4.407^{b}	41.24^{def}	326.07^{abc}
1:1CT/CS	10.44^{cd}	89.56^{ab}	2.887^{c}	19.59^{fg}	3.300^{fg}	2.657^{gh}	61.12^{a}	366.03^{abc}
1:2CT/CS	11.00^{abc}	89.00^{abc}	2.777^{c}	17.80^{fg}	2.857^{g}	2.470^{gh}	63.10^{a}	362.23^{abc}
2:1CT/CS	11.11^{abc}	88.89^{bc}	2.333^{c}	18.09^{fg}	3.683^{efg}	2.480^{gh}	62.30^{a}	368.03^{ab}
1:1SL/LB	10.45^{cd}	89.55^{ab}	7.000^{ab}	30.19^{bc}	3.893^{efg}	4.160^{bc}	44.31^{cde}	348.35^{de}
1:2SL/LB	11.33^{abc}	88.67^{bcd}	5.777^{ab}	26.84^{cd}	5.443^{bcd}	3.687^{cd}	47.20^{bcd}	359.59^{ad}
2:1SL/LB	10.22^{cd}	89.78^{ab}	6.447^{ab}	34.13^{b}	5.283^{bcd}	4.700^{b}	39.22^{efg}	358.83^{bcd}
Control	10.56^{cd}	89.44^{ab}	6.667^{ab}	34.14^{b}	6.663^{a}	4.710^{b}	37.26^{fg}	362.51^{abc}
Pr. of F	0.0044	0.0047	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004
S E ±	0.623	0.673	1.014	2.513	0.679	0.358	3.508	6.549

Values are means of three replications. Mean values in the same column with different letters differ significantly ($p \leq 0.05$) according to DMRT. CT = Castor oil, CS = Cashew oil, SLP = Scent Leaf Powder, LBP = Lemon Balm Powder.

This work showed that leaf powders biopesticides increase ash content of cowpea after storage, which could be due to infestation by *C. maculatus* that eats up the endosperm, leaving the seed coat, which is rich in ash as noted by Gerrano et al. (2015). The ranges of values recorded in this study were slightly higher than the ranges of values reported by Ajeigbe et al. (2008) and Ilesami and Gungula (2016). The import of the high ash content is an indication that the cowpea could be an important source of minerals and energy, as noted by Babarinde et al. (2016).

The leaf powder used could not give a long-term desirable protection against cowpea weevils due to a short persistence level, as such infestation by insects destroyed the cowpea grains, and subsequently the eggs, larvae, life, and death weevils present in the infested grains contributed to the higher protein content. However, samples treated with oils recorded the lowest values of proteins due to the low level of infestation by the weevils, which gave effective control against *C. maculatus* infestation. This study concurred with the finding of Gerrano et al. (2015), who reported that the significantly higher protein content could be due to the presence of many eggs and larvae of *C. maculatus* on the cowpea grains due to infestation. The protein content of this study was slightly higher than the range of values reported by Uduak (2018) on brown and white beans. This study also agrees with the findings of Ajeigbe et al. (2008), who reported that protein content is positively correlated with ash and fat and negatively correlated with carbohydrate content. This finding is similar to that of Davis et al. (1991), who reported on the proximate composition of various infested cowpea samples, indicating a higher percentage increase in the protein content in infested cowpea when compared with uninfested ones.

The high fat content observed on untreated and powder-treated cowpea could also be due to infestation by *C. maculatus*. The powders used could not provide a desirable protection against cowpea weevils, and hence, infestation set in, which destroyed cowpea grains, leaving weevil eggs, larvae, and live and dead insects that increase the fat content. The low percentage of fat content in cowpea subjected to oil treatments could be caused by its toxicity, repellency, and ovicidal effects on *C. maculatus*. The findings of this work are congruent with those of Khalid et al. (2012), who found that oils from some plants help to preserve cowpeas against weevil attacks.

The variation between oils and powders treated cowpea on the percentage crude fiber content recorded in oils treatments was very low when compared with powders treated cowpea. The low crude fiber content indicated that castor and cashew oils used were effective in bruchid control, while the high fiber content observed on cowpea treated with leaf powders and control is an indication that the powders used were not effective in protecting the treated cowpea up to 120 days. Thus, infestation by *C. maculatus* hollowed out cowpea grains and left behind the seed coat, which has high fiber content. These findings align with the results of Davis et al. (1991) and Uduak et al. (2018), who reported on the proximate composition of various infested cowpea.

The highest carbohydrate content was observed in cowpeas treated with castor and cashew oils, which could be due to the endosperm and the embryo that was not destroyed by *C. maculatus* during storage, which helps to conserve the carbohydrate content of the cowpea. However, the low value recorded in leaf powder-treated cowpea is an indication that the powder used was not strong enough to give complete suppression of *C. maculatus*, as such a bulk of carbohydrate content in the endosperm portion of cowpea grains was devoured by the insects after 120 days. Davis et al. (1991) also reported that there is a higher percentage increase in carbohydrates of infested cowpea when compared with not infested cowpea samples. Carbohydrates have been reported to influence the water absorption capacity of foods (Adejuyitan 2009). The result of this study is congruent with that of Ajeigbe et al. (2008), Ilesemi and Gungula (2016), and Therese et al. (2019), who noted that infested cowpea had lower carbohydrate content during storage.

Since carbohydrate content is the main substrate for respiration that produces energy, the high carbohydrate content observed in cowpeas treated with 2 ml castor and 3 ml cashew oil could be the reason for the high calorific value recorded. The calorific value is directly proportional to the carbohydrate content, as it provides the fuel for metabolic activities that produce the required energy. The results of this study are in agreement with those of Uduak (2018), who reported that infested cowpeas have a higher calorific value than those not infested, because the pests have exhausted the carbohydrate content of the grain. In addition, the value obtained in this work is similar to that recorded by Uduak (2018), 326.52 Kcal/g for brown beans and 381.19 Kcal/g for white beans.

In conclusion, castor and cashew oils may be more effective in *C. maculatus* control than scent leaf and lemon balm powders, but in terms of nutrient content conservation. The application of 10, 15, and 20 g of SLP could give the best moisture, dry matter, and ash content of the stored cowpea, while 15 g LBP had the best crude protein and fiber content. Similarly, cashew and castor oils at the concentration of 3 ml and mixed ratios of castor and cashew oils 1:1, 1:2, and 2:1 ml per 200 g of cowpea recorded the best carbohydrate content of the grains after storage.

ABSTRACT

Tame, V.T., Gungula, D.T., and Zira, D.K. 2025. Influence de biopesticides sur la teneur en nutriments du niébé (*Vigna unguiculata*) stocké à Yola, État d'Adamawa, Nigéria. Tunisian Journal of Plant Protection 20 (2): 57-67.

L'influence de biopesticides sur la teneur en nutriments des graines de niébé stockés a été étudiée afin de déterminer l'effet de ces extraits végétaux sur leur composition. Les traitements consistaient à traiter des graines de niébé avec de l'huile de ricin, de l'huile de noix de cajou, de la poudre de la mélisse et de la poudre de feuilles de basilic africain (ou encens), pures ou en mélange, appliquées à différentes doses. L'expérience a été menée selon un dispositif complètement randomisé (PCR) avec 18 traitements répétés trois fois et un stockage de 120 jours. Les résultats ont montré un effet hautement significatif des extraits végétaux sur la composition des graines. Les niébés traités avec 10 g de poudre de feuilles de basilic africain (PFA) présentaient la teneur en eau la plus élevée (12,11 %). Les graines traitées avec 15 g de PFA affichaient également les teneurs les plus élevées en cendres et en protéines brutes (7,22% et 39,39%, respectivement), tandis que ceux traités avec 20 g de PFA présentaient la teneur en matières grasses brutes la plus élevée (6,80%). Concernant les fibres brutes, les échantillons traités avec 15 g de poudre de mélisse (PM) présentaient la teneur la plus élevée (5,43%), tandis que les graines traitées avec 20 g de PM affichaient la teneur en matière sèche la plus importante (90,22%). Les échantillons traités avec de l'huile de ricin pure ou en mélange avec de l'huile de noix de cajou présentaient les teneurs en glucides les plus élevées (66,98 à 66,79 %), tandis que la valeur calorique la plus élevée a été observée pour les échantillons traités avec 2 ml d'huile de ricin (372,31 kcal/g).

Mots clés: Biopesticides, *Callosobruchus maculatus,* huile de noix de cajou, huile de ricin, niébé, poudre d’encens, poudre de mélisse, *Vigna unguiculata*

تلخيص

تام، فادلاي تيزهي ودانيال تيرّمون قونقولا ومحمد أحمد ودلما كوادا زيرا. 2025. تأثير المبيدات الحيوية على المحتوى الغذائي للوبيا المخزنة (*Vigna unguiculata*) في يولا، ولاية أداماوا، نيجيريا.
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دُرست تأثيرات المبيدات الحيوية على المحتوى الغذائي لحبوب اللوبيا المخزنة لتحديد تأثير هذه المستخلصات النباتية على تركيبها الكيميائي. شملت المعاملات معالجة حبوب اللوبيا بمسحوق نقي ومخاليط من زيت الخروَع، وزيت الكاجو، ومسحوق المليسة، ومسحوق أوراق الريحان، بتراكيز مختلفة. صُممت التجربة وفق تصميم عشوائي كامل (CRD) بـ 18 معاملة، كُررت ثلاث مرات، وخُزّنت الحبوب لمدة 120 يومًا. أظهرت النتائج تأثيرًا معنويًا للغاية للمستخلصات النباتية على المحتوى الكيميائي للحبوب. احتوت حبوب اللوبيا المعالجة بـ 10 غ من مسحوق أوراق الريحان على أعلى نسبة رطوبة (12.11%)، كما سجلت الحبوب المعالجة بـ 15 غ من مسحوق أوراق الريحان أعلى نسبة رماد وبروتين خام (7.22% و39.39% على التوالي)، بينما أظهرت حبوب اللوبيا المعالجة بـ 20 غ من مسحوق أوراق الريحان أعلى نسبة دهون خام (6.80%). فيما يتعلق بالألياف الخام، سجلت العينات المعالجة بـ 15 غ من مسحوق بلسم الليمون أعلى نسبة (5.43%)، بينما أنتجت الحبوب المعالجة بـ 20 غ من مسحوق بلسم الليمون أعلى نسبة من المادة الجافة (90.22%). وسجلت كل من العينات المعالجة بزيت الخرَوع النقي ومزيج زيت الكاجو أعلى نسبة من الكربوهيدرات (66.98-66.79%)، في حين سُجلت أعلى قيمة حرارية في العينات المعالجة بـ 2 مل من زيت الخروَع (372.31 كيلو كالوري/غ).

كلمات مفتاحية: زيت الخروع، زيت الكاجو، لوبيا، مبيدات حيوية، مسحوق أوراق الريحان، مسحوق بلسم الليمون، *Callosobruchus maculatus*، *Vigna unguiculata*

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