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Determination of biochemical changes during storage of cowpea infested with the cowpea weevil (Callosobruchus Maculatus F.)

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ABSTRACT

The present work was carried out to throw light on the relationship between the infestations with Callosobruchus Maculatus on the consumption of the chemical component of the cowpea seeds. Results showed that the increase of storage period of cowpea lead to increase of the mean No. of emerged adults of Callosobruchus Maculatus F. from 20 adults at the start of the experiment to 343.3 ± 0.09 and 2143.3 ± 0.70 adults after one and four months of storage, respectively and apparently affected weight loss and germination of stored cowpea seeds. In addition, there were distinct differences in the chemical components of the infested and uninfested cowpea seeds such as moisture, ash, crude proteins, crude lipids, crude fibers, carbohydrates, soluble sugars, reducing and non-reducing sugars. However, cowpeas could be considered as a good source of Potassium, Magnesium, Sodium, Calcium and Iron.

Key words:

Introduction

Pulses are a good source of dietary proteins and other essential nutrients. However, post- harvest insect infestation are severely affects quality and shelf-life of products (Hassan and Umar, 2005, and Mbata *et al.*, 2005).

Callosobruchus Maculatus F. is one of the most serious brunched pests which attack one of the most important pulse food produced and consumed in Egypt (Hussain and Basahy, 1998).

The effect of infestation of certain coleopterous insects on the chemical components of leguminous seeds was studied by (El-Degwi and El-Orabi, 1997 and Fouad and Gamal, 2000). The determinations of quality loss of stored grain are necessary to determine the rate of physical and biochemical deterioration of these grains (Sanon *et al.*, 2010).

The present investigation was carried out to determine the effect of infestation with cowpea weevil, C. Maculatus on the chemical components of the stored cowpea seeds.

Materials and Methods

A. Infestation of cowpea with insects:

Cowpea weevil, Callosobruchus Maculatus F. was obtained from laboratory culture reared on cowpea seeds (Vigna Unguiculata) in an incubator maintained at 30± 2°C and 70 ± 5 % (Room Humidity). Experiments were conducted under the same conditions.

The storage experiment was carried out by of 200 grams of cowpea seeds were put in small glass jars and infested with 10 pairs of newly emeged adults of C. Maculatus. The jars were stored for one and four months under the experiment conditions. Jars containing uninfested cowpea and uninfested cowpea.

At the end of each storage period, adults of C. Maculatus were isolated from each jar and counted; also samples of cowpea seeds were taken randomly from each jar to determine seed weight loss, moisture content, seed germination and changes in chemical components. The weighted seed was determined according to the method of El-Degwi and El-Orabi, 1997, as the weight loss of each sample was assessed by the following equation:

$$\% \text{ Weight loss} = \frac{\text{Weight of un infested seeds} - \text{Weight of infested seeds}}{\text{Weight of un infested seeds}} \times 100$$

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Seed germination was determined by placing 25 seeds around the perimeter of a sterile Petri-dish containing a sterile filter paper soaked with 4 ml of sterile distilled water. The Petri-dishes were incubated at 25 ± 1°C and percent germination was calculated after 7 days.

Determination of chemical composition of cowpea seeds:

Moisture content and crude protein (% N 6.25) of cowpea seeds were determined according to the method described by (A.O.A.C, 1984). Crude fibers were determined according to the A.O.A.C., (1990). Total hydrosable carbohydrates were calculated as glucose by phenol-sulphuric acid method. Ash and lipid contents were determined by (A.O.A.C., 1990). Phytate content was extracted according to the procedure described by Norhaizan and Nor Faizadatul (2009). Trypsin inhibitor content was assayed by the method of Hilary Goetz (2011). The total soluble sugars were colourmetrically determined according to the method of and reducing sugars were determined according to Kolusheva, and Marinova, (2011).

Determination of minerals in cowpea seeds:

The minerals of cowpea seeds were determined according to the method of A.O.A.C. (1990) by using atomic absorption spectroscopy a Perkin-Elmer 3280.

Statistical analysis:

The data were statistically analyzed using the analysis of variance as outlined by Snedecor and Cochran (1967).

Results and Discussion

Table 1: Effect of Callosobruchus Maculatus F. infestation on weight loss and germination of stored cowpea seeds (starting with 20 adults).

Storage Period	Mean No. of emerged adults ± S.E.	Weight loss % of Cowpea seeds	Germination % of	
			Uninfested seeds	Infested seeds
One month	343.3±0.9	46.33	79	2
Four months	2143.3±0.7	67.33	84	0

Table 2: Effect of Callosobruchus Maculatus F. infestation on the chemical components of cowpea seeds stored for one month.

Components of cowpea seeds	Un infested cowpea seeds	Infested cowpea seeds	% of Difference
Moisture content %	8.6 ±0.01	8.9±0.08	
Total ash %	3.40±0.11	5.98±0.10	+ 76
Crude fiber %	5.04±0.02	6.63±0.01	+ 32
Crude lipids %	0.90±0.2	1.01±003	+ 12
Crude protein %	26.1±0.17	25.9±1.15	- 1
Total Carbohydrates %	67.5±0.17	64.5±0.28	- 4
Reducing Sugars %	0.87±0.01	0.72±0.02	- 14
Non-reducing sugars %	6.72±0.90	2.48±0.02	- 59
Total soluble sugars %	6.99±0.10	3.20±0.05	- 54
Starch %	42.0±0.17	41.40±0.11	- 1
Trypsin Inhibitor Activity (IU/mg)	26.1±0.11	30.01±0.05	+ 15
Phytic acid (mg/100g)	346.92±0.07	354.8±0.07	+ 2

+ Means increased from Un-infested one
- Means decreased from Un-infested one

Table 3: Effect of Callosobruchus Maculatus F. infestation on the minerals content of cowpea seeds stored for one month.

Minerals (mg/100g)	Un infested cowpea seeds	infested cowpea seeds
Zinc (Zn)	1.956	2.462
Potassium (K)	448.76	926.17
Sodium (Na)	20.10	34.56
Manganses (Mn)	0.929	1.034
Cupper (Cu)	1.175	3.035
Calcium (Ca)	15.575	14.94
Magnesium (Mg)	427.28	724.23
Iron (Fe)	3.789	3.448

Table 4: Effect of Callosobruchus Maculatus F. infestation on the chemical components of cowpea seeds stored for four months.

Components of cowpea seeds	Un infested cowpea seeds	Infested cowpea seeds	% of Difference
Moisture content %	9.60±0.02	9.93±0.01	
Total ash %	3.75±0.05	7.8±0.11	+ 105
Crude fiber %	4.8±0.05	11.9±0.4	+ 148
Crude lipids %	1.26±0.01	3.67±0.01	+ 185
Crude protein %	27.2±0.11	25.3±0.44	- 5
Total Carbohydrates %	60.8±0.45	60.0±0.17	- 1

Reducing Sugars %	0.76±0.02	0.68±0.03	- 13
Non-reducing sugars %	6.36±0.02	2.74±0.08	- 55
Total soluble sugars %	7.12±0.04	3.42±0.01	- 52
Starch %	41.35±0.02	40.01±0.05	- 4
Trypsin Inhibitor Activity (IU/mg)	25.7±0.14	29.9±0.23	+16
Phytic acid (mg/100g)	367.50±0.15	380.04±0.08	+ 4

+ Means increased from Un-infested one
- Means decreased from Un-infested one

Table 5: Effect of Callosobruchus Maculatus F. infestation on the minerals content of cowpea seeds stored for four months.

Minerals (mg/100g)	Un infested cowpea seeds	infested cowpea seeds
Zinc (Zn)	19.40	24.55
Potassium (K)	4487.3	9261.1
Sodium (Na)	201.0	345.4
Manganses (Mn)	9.26	10.30
Cupper (Cu)	11.70	30.30
Calcium (Ca)	152.90	149.0
Magnesium (Mg)	7272.4	7242.1
Iron (Fe)	37.80	34.40

A- Effect of infestation with Callosobruchus Maculatus F. on weight loss and germination of stored cowpea seeds:

Data in Table (1) record that the mean No. of emerged adults of Callosobruchus Maculatus F., increased significantly ($P<0.05$) from 20 adults at the start of the experiment to 343.3 ± 0.09 and 2143 ± 0.70 adults after one and four months of storage at ambient temperature, respectively. As indicated in Table (1), the increment in No. of emerged adults apparently affected weight loss and germination of stored cowpea seeds. Data show that weight loss of cowpea was significantly ($P<0.05$) increased from 46.33 after one month to 67.33 after four months of storage. These results are in agreement of El-Degwi and El-Orabi, (1987) who recorded the weight loss of cowpea and chickpea infested with Callosobruchus Maculatus F. The loss in cowpea weight would be attributed to feeding behavior of insects inside the seeds. Data in Table (1) reveal that the germination of stored cowpea decreased significantly ($P<0.05$) from 79% and 84% for un infested cowpea to 2 % and zero % for the infested cowpea after one and four months of storage, respectively, Sharma et al., (2010) reported that reduction of seed germination could be due to the insect feeding on seed germ that prevents seed germination.

B- Effect of infestation with Callosobruchus Maculatus F. on chemical components of stored cowpea seeds:

The gross chemical analysis of the studied cowpea is given in Table (2 and 4). Moisture content of un-infested cowpea increased from 8.6 ± 0.01 after one month to 9.60 ± 0.02 after four month of storage. On the other hand, the infested cowpea, moisture content increased from 8.9 ±0.08 after one month to 9.93±0.01 after four months. These results indicate considerably low moisture contents. Generally, the moisture content of dry legume seeds ranges between 8 % and 12 % as reported by Ahenkora K. *et al.,* (1998). Moisture content of 13 American cowpea varieties ranged from 7.9 – 11.7 %. These findings are in accordance with the reported ones and the moisture content of local cowpeas depending on varieties differences and insect infestation (Agbenorhevi *et al*., 2007).

The changes in the amount of total ash are shown in Table (2 and 4). For the uninfested cowpea, the amount of total ash increased slightly from 3.40 ± 0.11 after one month to 3.75 ± 0.05 after four months of storage. Khalaf Allah (1995) has reported that ash content in raw beans (kidney beans, dry beans and mung beans) ranged between 3.7 and 6.6 %. For infested cowpea, the amount of total ash increased significantly ($P<0.05$) from 5.98 ± 0.10 after one month to 7.8 ± 0.11 after four months of storage.

Similar findings were recorded by El-banby (1985), who found that bruchid beetles such as Bruchidius incarnates Boh., and C. maculates infestation caused increase in total ash.

It has been reported that cowpea contains considerable amounts of fibers, however the results obtained in Tables (2 and 4) indicate that the uninfested and infested cowpea contained 5.04 ±0.02 and 6.63±0.01 and 11.9±0.40 after four months, respectively. The difference in the amount of fiber between the infested and uninfested cowpea was not significantly different ($P< 0.05$) after one month. On the other hand, after four month, significant difference was found ($P<0.05$) between infested and uninfested cowpea , Khalaf Allah (1995) reported that total fibers contents of legumes ranged from 2.0% to 10%.

The data shown in Tables (2 and 4) indicate that the protein content of uninfested cowpea was found to be 26±0.17 and 27±0.11 after one and four months of storage, respectively. This indicates no great differences in protein content. These results are closed to those found by Coelho *et al.,* (2010) who reported that protein content of legumes ranged from 20.1 % to 30%. Akinlosotu and Akinyele (1991) illustrated that the average

protein content of one variety of cowpea ranged between 20.7% and 28.1% coinciding to a great extent with the present findings.

Cowpea seeds were found to contain relatively low contents of lipids (Tables 2 and 4) ranging between 0.90 ±0.02 and 1.26 ±0.01 for the uninfested seeds and 1.01 ± 0.03 and 3.67 ± 0.01 for the infested ones after one and four months of storage, respectively. These results agree with the findings of who reported 2.5 % fat in different legumes.

From the data in Tables (2 and 4) it could be noticed that uninfested cowpea stored for one and four months contained considerably high contents of carbohydrates, i.e., 67.5 ±0.17 and 60.8 ± 0.45 respectively. Infestation of cowpea seed with C. maculates results in decrease in total carbohydrates to reach 64.5 ± 0.28 and 60.0 ± 0.17, respectively. These results are in agreement with the finding of El-Dessouki *et al.,* (1984) who reported that sound seed of mung bean contain 55-64% total carbohydrates.

Phytic acid is one of the organic components most widely associated with the protein availability and consequently the nutritive value of most legumes on their processing and for consumption (Ghadge *et al.,* 2008).

The mineral contents of the legume seeds under investigation were determined in the ash resulting from cowpea seeds. The results obtained are given in Tables (3 and 5), from which it could be noticed that minerals content of (Iron, Cupper, Manganese, Zinc, Sodium, Potassium and Calcium) were 3.78, 1.17, 0.93, 427.28, 1.95, 11.7, 9.26, 7272.4, 19.4, 201, 4487.3 and 152.7 mg/100g after four months respectively.

From these results it could be concluded that cowpea could be considered as a good source of Potassium, Magnesium, Sodium, Calcium and Iron which is quite important from the nutritive point of view. These results agree with the findings of (Ghadge *et al.,* 2008).

Recommendations:

This study recommended that, it is necessary to examine the cereals and seeds for insects and microbial infestation before processing and human consumption to keep its nutritional values during storage and to ensure that it is empty from any harmful materials.

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