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EVALUATION OF NUTRITIONAL QUALITY PARAMETERS IN CHICKPEA TREATED WITH PLANT BASED SILICA PRODUCTS

B. V. Jayanth[1*], A. Padmasri[2], M. Shashikala[1], T. Uma Maheswari[2], Mohibbe Azam[3] and Gundreddy Rajareddy[1]

[1]Division of Entomology, ICAR- Indian Agricultural Research Institute, New Delhi - 110 012, India.

[2]Professor Jayashankar Telangana State Agricultural University, Hyderabad (A.P.), India.

[3]ICAR- Indian Institute of Rice Research, Hyderabad (A.P.), India.

*Corresponding author E-mail : bvjayanth555@gmail.com

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ABSTRACT

The effect of plant based silica products *viz.*, amorphous silica gel @ 250 and 500 ppm, amorphous silica precipitate @ 250 and 500 ppm kg^{-1} seed, paddy husk @ 1000 and 2000 ppm kg^{-1} seed, paddy leaves @ 1000 and 2000 ppm kg^{-1} seed and diatomaceous earth @ 300 and 600 ppm kg^{-1} seed on nutritional quality parameters like carbohydrates, protein content and crude fat were studied in chickpea seeds. These plant based silica products have shown significant negative effect on carbohydrate and crude fat while, positive effect on protein content which might be due to the increased infestation of pulse beetle and storage period. Among the plant based silica products, amorphous silica gel @ 500 ppm kg^{-1} seed resulted in highest carbohydrate and crude fat content besides lowest protein content compared to other treatments indicating its effectiveness. However, all the treatments recorded high carbohydrate, crude fat content and low protein content compared to untreated control at six months of storage.

Key words : Plant based silica products, Chickpea, Carbohydrates, Proteins, Fat.

Introduction

Pulses are considered as the most nutritious and play a crucial role in fulfilling protein deficiency in daily diet of the people. Among them, chickpea has been a traditional low-input crop in the farming systems of the Indian subcontinent where it is an integral part of the daily diet of the people because of its adaptability to a wide range of environments.

There is a growing demand for chickpea due to its nutritional value. It is a good source of carbohydrates and protein, together constituting about 80% of the total dry seed mass. Lipids are present in low amount but rich in important unsaturated fatty acids like linoleic acid and oleic acid (Jukanti *et al*., 2012).

Insects extensively cause damage to stored grains and the grain products which accounts to 5 to 10 per cent in temperate and 20 to 30 per cent in tropical zones (Nakakita, 1998). The most important insect damaging chickpea in storage are bruchids or pulse beetles (*Callosobruchus* sp), Rust-red flour beetle (*Tribolium castaneum*), Lesser grain borer (*Rhyzopertha dominica*) *etc*. Among major pulse beetles, *Callosobruchus chinensis* and *Callosobruchus maculatus* are prominently distributed in Asia and Africa which cause more than 50 per cent damage to stored cereals and legumes (Giles, 1977; Sharma, 1984; Bindhu *et al*., 2015; Khan *et al*., 2015).

The extensive application of insecticides is directly related with the development of resistance of stored product insect species, raising serious concerns for human health as a result of food contamination with residues and possible environmental hazards (Boyer *et al*., 2012; Stadler *et al*., 2012).

In this context, the use of plant derived products is considered promising alternative to currently used traditional pesticides against stored product insects (Weaver and Subramanayam, 2000).

The current study was aimed to examine the nutritional quality parameters of chickpeas treated with plant-based silica products involves evaluating various aspects such as carbohydrate composition, protein content and crude fat. While specific studies on chickpeas treated with plant-based silica products may be limited, research on similar topics can provide insights into the methodologies and considerations for such assessments.

Materials and Methods

The experiment was conducted in the Entomology laboratory, Seed Research and Technology Centre and Central Instrumentation Cell, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana. To assess the effect of plant based silica products on nutritional quality parameters such as carbohydrate, protein and crude fat, estimation was done before and after treatment by using standard procedures.

Table 1 : Details of the plant based silica treated to the chickpea and their dosages.

S. no.	Treatments	Dosages
T_1	Amorphous silica gel	250 ppm
T_2	Amorphous silica gel	500 ppm
T_3	Amorphous silica precipitate	250 ppm
T_4	Amorphous silica precipitate	500 ppm
T_5	Paddy husk	1000 ppm
T_6	Paddy husk	2000 ppm
T_7	Paddy leaves	1000 ppm
T_8	Paddy leaves	2000 ppm
T_9	Diatomaceous earth	300 ppm
T_{10}	Diatomaceous earth	600 ppm
T_{11}	Untreated control	-

Carbohydrates (per cent)

Phenol sulphuric acid method as described by Sadasivam and Manickam (2008 a) has been used for determining carbohydrate content in stored chickpea seeds. 100 grams of sample was taken into a boiling tube and hydrolysed by keeping it in a boiling water bath for nearly about three hours with five ml of 2.5 N HCL. After cooling it to room temperature, it was neutralised with solid sodium carbonate until the effervescence ceased. Then the volume ^{0} is made to 100 ml and then centrifuged. 0.2, 0.4, 0.6, 0.8 and 1ml of working standards and aliquots (0.1 and 0.2 ml) were pipetted out into a series of test tubes. The volume was made to 1 ml with water and also a blank was set with 1 ml of water. 1 ml of phenol solution and 5 ml of 96% sulphuric acid was added to each tube and shook well. After shaking the contents in the tubes for ten minutes, they are placed in a water bath for 20 minutes at 25-30^{0}C. The absorbance has been measured using spectrophotometer at 490 nm and from the standard graph. The amount of carbohydrate content present in the samples was calculated as follows

Absorbance corresponds to 0.1 ml of the test = 'x' mg of glucose

$$100 \text{ ml of sample solution contains} = \frac{x}{0.1} \times 100 \text{ mg of glucose}$$

=…per cent of carbohydrate present

Proteins (per cent)

The protein content was determined by available nitrogen in the sample by micro-Kjeldahl method as described by Sadasivam and Manickam (2008 b) using Kelplus auto analyser. Initially in the presence of 2 grams of catalyst mixture (copper sulphate and potassium sulphate in the ratio of 1: 5) and ten ml of concentrated sulphuric acid, 0.2 g of sample was digested at 420^{0}C for 2 hours. The distillation has been carried out after cooling in auto distillation system (loaded with 40 per cent sodium hydroxide and 4 per cent boric acid). The obtained distillate was titrated against 0.1 N HCL till pink colour has appeared. The per cent nitrogen has been calculated as follows.

$$N_2(\%) = \frac{\left[\begin{matrix}\text{Titre value of the sample} - \\ \text{Titre value of the blank}\end{matrix}\right] \times 14 \times \text{Normality of HCL (0.1)}}{\text{Weight of the sample} \times 1000} \times 100$$

The protein content was estimated in per cent by multiplying the obtained nitrogen per cent with factor 6.25 (Mariotti *et al*., 2008).

Crude fat (per cent)

Crude fat was determined by AOAC 922.06-2006 method in Quality control laboratory, Rajendranagar, Hyderabad. Empty fat extraction beaker along with boiling stones (T) was weighed. Approximately 2 grams of the sample was weighed in triplicates and packed into filter paper and placed in the thimbles provided with the instrument. Volume of n-Hexane taken in a beaker was recorded. Required conditions for soxtherm extraction were maintained as per software settings and thimble containing mango sample was inserted into the slot provided for thimbles. The thimble containing the test portion was immersed into the boiling solvent. The intermixing of the matrix with hot solvent ensure rapid solubilization of extractable. In the second step, the thimble was raised above the solvent and the test portion was further extracted by a continuous flow of condensed solvent for 1 hour, 20 min. The solvent was evaporated and recovered by condensation. After drying, the resulting

crude fat residue was determined gravimetrically. Extraction cups were dried at $102^0C \pm 2^0C$ in a hot air oven for 30 minutes to remove moisture. Excessive drying was avoided which can oxidize fat and give erroneous results. The defatted sample was cooled in a desiccator and weighed to the nearest 0.1 mg (F). The per cent crude fat was calculated as follows

$$\% \text{ per cent crude fat, Hexanes / equivalent extract} = \frac{F - T}{S} \times 100$$

Where, F = weight of cup + fat residue in grams

T = weight of empty cup in grams

S = Test portion weight in grams.

Results

In the present investigation, the nutritional quality parameters *viz*., carbohydrate, proteins and crude fat in treated chickpea were assessed and the results are presented below

Carbohydrate : The carbohydrate content in other treatments varied from 58.66 to 60.54 per cent. The treatments were *viz*., paddy leaves @ 1000 ppm kg^{-1} seed (58.66) and paddy leaves @ 2000 ppm kg^{-1} seed (58.78), which were found to be on par with each other followed by paddy husk @ 1000 ppm kg^{-1} seed (59.37) and paddy husk @ 2000 ppm kg^{-1} seed (59.88). However, amorphous silica precipitate @ 250 ppm kg^{-1} seed (60.50 per cent), diatomaceous earth @ 300 ppm kg^{-1} seed (60.52 per cent), amorphous silica precipitate @ 500 ppm kg^{-1} seed (60.53 per cent), amorphous silica gel @ 250 ppm kg^{-1} seed (60.54 per cent) and diatomaceous earth @ 600 ppm kg^{-1} seed (60.66 per cent) remained on par with each other.

Table2 : Effect of plant based silica products treatment on carbohydrates, proteins and crude fat of chickpea seeds during storage.

Treatments	Dosage kg^{-1} seed	Carbohydrates (per cent)	Proteins (per cent)	Crude fat (per cent)
Amorphous silica gel	250 ppm	60.54 (51.06)	24.94 (29.95)	3.95 (11.45)
Amorphous silica gel	500 ppm	61.11 (51.40)	24.23 (29.48)	4.09 (11.67)
Amorphous silica precipitate	250 ppm	60.50 (51.04)	25.28 (30.17)	3.74 (11.15)
Amorphous silica precipitate	500 ppm	60.53 (51.06)	25.06 (30.03)	3.94 (11.44)
Paddy husk	1000 ppm	59.37 (50.38)	27.26 (31.46)	3.10 (10.13)
Paddy husk	2000 ppm	59.88 (50.68)	26.71 (31.11)	3.17 (10.25)
Paddy leaves	1000 ppm	58.66 (49.97)	28.10 (31.10)	2.89 (9.78)
Paddy leaves	2000 ppm	58.78 (50.04)	27.98 (31.92)	2.96 (9.89)
Diatomaceous earth	300 ppm	60.52 (51.05)	25.14 (30.08)	3.86 (11.32)
Diatomaceous earth	600 ppm	60.66 (51.14)	24.72 (29.80)	4.05 (11.61)
Untreated control	-	57.96 (49.56)	28.77 (32.43)	2.77 (9.58)
SEm ±		0.17	0.18	0.05
CD (P = 0.05)		0.51	0.53	0.15
CV(%)		0.59	1.01	0.82
Initial		61.78	21.98	4.26

The values in parentheses are angular transformed values.

Protein : Protein content of 21.98 per cent was found initially in fresh seeds, which were found to increase in all the treatments with increase in the storage period. The lowest protein per cent of 24.23 was observed in amorphous silica gel @ 500 ppm kg^{-1} seed followed by diatomaceous earth @ 600 ppm kg^{-1} seed (24.72) and highest protein content of 28.77 per cent was recorded in untreated control after six months of storage.

The protein content in rest of the treatments *viz*., amorphous silica gel @ 250 ppm kg^{-1} seed (24.94), amorphous silica precipitate @ 500 ppm kg^{-1} seed (25.06), diatomaceous earth @ 300 ppm kg^{-1} seed (25.14), amorphous silica precipitate @ 250 ppm kg^{-1} seed (25.28) were found to be on par with each other. These were followed by paddy husk @ 2000 ppm kg^{-1} seed (26.71) and paddy husk @ 1000 ppm kg^{-1} seed (27.26). While, paddy leaves @ 2000 ppm kg^{-1} seed (27.98) and paddy leaves @ 1000ppm kg^{-1} seed (28.10) remained on par with each other.

Crude fat : Though, the initial crude fat content recorded was 2.77 per cent, with increase in the storage period, the crude fat content was found to decrease in all the treatments. Six months after treatment imposition, significant differences among the treatments was found but crude fat per cent was found to be highest in amorphous silica gel @ 500 ppm kg^{-1} seed (4.09) which was found to be on par with treatments *viz*., diatomaceous earth @ 600 ppm kg^{-1} seed (4.05), amorphous silica gel @ 250 ppm kg^{-1} seed (3.95) and amorphous silica precipitate @ 500 ppm kg^{-1} seed (3.94). The treatments *viz*., diatomaceous earth @ 300 ppm kg^{-1} seed (3.86) and amorphous silica precipitate @ 250 ppm kg^{-1} seed (3.74) remained on par with each other.

The treatments *viz*., paddy husk 2000 ppm kg^{-1} seed (3.17) and paddy husk @ 1000 ppm kg^{-1} seed (3.10) remained on par with each other. Similarly, paddy leaves @ 2000 ppm kg^{-1} seed (2.96) and paddy leaves @ 1000 ppm kg^{-1} seed (2.89) also remained on par with each other. The lowest crude fat per cent was observed in untreated control (2.77).

Discussion

The effect of plant based silica products *viz*., amorphous silica gel @ 250 and 500 ppm, amorphous silica precipitate @ 250 and 500 ppm kg^{-1} seed, paddy husk @ 1000 and 2000 ppm kg^{-1} seed, paddy leaves @ 1000 and 2000 ppm kg^{-1} seed and diatomaceous earth @ 300 and 600 ppm kg^{-1} seed on nutritional quality parameters like carbohydrates, protein content and crude fat were estimated in chickpea seeds.

Carbohydrate content decreases with increase in the storage duration and insect infestation Garbaba *et al*. (2017). Abdelfattah and Zein (2019), who reported that, carbohydrate content decreased in untreated wheat (75.23 per cent) compared to wheat treated with Aerosil (76.05) after six months of storage period.

The increase in the protein content might be due to the accumulation of insect exuviae and frass inside the grains which tends to increase the total nitrogen content of the grains (Bamaiya *et al*., 2006). The present investigations are in conformity with the findings of Omobowale and Akomolafe (2021), who reported that protein content in cowpea increased from 20.4 per cent to 24.6 and 24.4 in untreated and diatomaceous earth treated seeds, respectively after three months of storage. Jood and Kapoor (1993) also noticed increase in total nitrogen, non-protein nitrogen, uric acid and total protein with increased infestation levels.

Insect infestation causes increase in the breakdown of fats into fatty acids which affects the total fat content as reported by Bamaiyi *et al*. (2006). Present investigations revealed that fat content declined significantly with increased infestation levels of the insect and storage period which is in conformity with Samuels and Modgil (2003). Similarly, Stefanello *et al*. (2015) also showed that fat per cent decreased from 5.8 to 5.0 per cent after storing for a period of nine months.

Conclusion

The effect of plant based silica products *viz*., amorphous silica gel @ 250 and 500 ppm, amorphous silica precipitate @ 250 and 500 ppm kg^{-1} seed, paddy husk @ 1000 and 2000 ppm kg^{-1} seed, paddy leaves @ 1000 and 2000 ppm kg^{-1} seed and diatomaceous earth @ 300 and 600 ppm kg^{-1} seed on nutritional quality parameters like carbohydrates, protein content and crude fat were also studied in chickpea seeds. These plant based silica products have shown significant negative effect on carbohydrate and crude fat while, positive effect on protein content which might be due to the increased infestation of pulse beetle and storage period. Among the plant based silica products, amorphous silica gel @ 500 ppm kg^{-1} seed resulted in highest carbohydrate and crude fat content besides lowest protein content compared to other treatments indicating its effectiveness. However, all the treatments recorded high carbohydrate, crude fat content and low protein content compared to untreated control at six months of storage.

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