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Quantitative and Qualitative Losses in Chickpea var. *Desi* Channa due to *Suidasia nesbitti* Hughes (Arachnida: Acari)

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ABSTRACT

Background: *Suidasia nesbitti* Hughes (Arachnida**:** Acari) infests variety of food stuffs and feed on whole grains, broken grains and flour of chickpea and causes qualitative and quantitative losses. The mite infestation resulted in significant decrease in the protein, total soluble sugars, non-reducing sugars and starch content of all the three forms of Bengal gram at 90 and 180 days of infestation. In contrast, reducing sugars significantly increased with increase in *S. nesbitti* infestation period.

Methods: Exposure of whole, broken grains and flour of chickpea var., *Desi* channa to *Suidasia nesbitti* (Acari: Suidasiidae) population was studied during monthly data analysis.

Result: The results showed that between the three forms, *Desi* channa flour harboured significantly more number of mites (4226.00 mites/g channa) than broken (2478.66 mites/g channa) and whole (260.00 mites/g channa) grains. Irrespective of forms, maximum number of mites was recorded at 180 days. Progressive blackening of broken grains and flour of *Desi* channa was witnessed with increase in observation period and the infested material emitted characteristic pungent odour.

Key words: Chickpea, Protein, Qualitative loss, Quantitative loss, Sugars, *Suidasia nesbitti.*

INTRODUCTION

Storage mites are among the most troublesome pests due to their high multiplication rates, short life span, overlapping generations with females as major constituent of their population and their interaction with insects and fungi in causing quantitative and qualitative deterioration of grains. Mites are microscopic arachnids which often go unnoticed until their numbers are significant.

Approximately, 70 species of mites have been reported (Malik *et al*., 2018) that infest food products of high protein and fat content (Anita, 2016). These include pulses, grains, flour, corn, cheese, pet foods, dry pet food, grain products, spices, baking mixes, dried vegetable materials and dried fruits.

Among pulses, chickpea is a good source of high digestible proteins, complex carbohydrates, phosphorus, calcium, magnesium, iron and zinc (Ibrikci *et al*., 2003). *Desi* type chickpea accounts for 80-85 per cent of world production the rest being *Kabuli* type (Verma *et al*., 2021). *Suidasia nesbitti* Hughes (Arachnida: Acari) infests variety of foodstuffs, broken grains, pulses, barley, cowpea, bean, maize, mushroom, rice, soybean, wheat grain, peanut, dehydrated plants of thyme, sage, chilli powder, onion, ginger (dried), garlic, tea, tulip, fish (dried), prawn, shrimp (dried), cured fish and meat (dried) (Ardeshir *et al*., 2000 ; Hagstrum *et al*., 2013). It is associated with loss in germination by 46.30, 69.8 and 73.13 per cent in wheat (Nangia and Channa Basavanna, 1989), pulses (Singh and Mathur, 1995) and pearl millet (Seema, 2020) along with other qualitative changes. The present study was conducted to evaluate the potential of *S. nesbitti* in causing quantitative and qualitative damage in chickpea var. *Desi* channa.

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MATERIALS AND METHODS

Mite culture on wheat flour was maintained in desiccators containing super saturated solution of potassium chloride at 80-85 per cent relative humidity and 27±1°C in BOD incubator. Chickpea variety, *Desi* was procured from Department of Genetics and Plant Breeding, CCS HAU, Hisar. Whole grains were coarsely grinded to make broken grains and finely grinded, sieved to make flour. The year of experiment was one year and the research work was carried out in CCS HAU, Hisar.

Quantitative losses in chickpea

Three forms; whole, broken grains and flour were used to estimate quantitative losses due to *S. nesbitti* infestation. For each form, sub sets of different durations *viz*., 30, 60, 90, 120, 150 and 180 days were prepared under triplicate conditions with 20 mites (Woolley, 1988) of *S. nesbitti* in one g grains or flour. Each form (whole, broken grains and flour) of non-infested material acted as corresponding control. After 30 days of the initiation of the experiment, one

sub set was taken out (3 replicates) from the desiccators along with three replicates of control to count the number of mites and symptoms of damage. Mites were counted under stereo zoom (37.5x) microscope in square counting dish. Similarly, second sub set of each form was removed after 60 days, third sub set after 90 days, fourth after 120 days, fifth after 150 days and sixth sub set after 180 days was removed and processed as above.

Qualitative losses in chickpea

The infested whole, broken grains and flour Bengal gram were subjected to biochemical estimation after 90 and 180 days and compared with non-infested grains/flour. After separation of mites through Berlese Funnel method at 90 and 180 days, protein (A.O.A.C, 1980), total soluble sugars (Yemm and Willis, 1954), reducing sugars (Nelson, 1944; Somogyi, 1945), non-reducing sugars and starch (Clegg, 1956) were estimated following standard procedures. These were compared with the protein, total soluble sugars, reducing sugars, non-reducing sugars and starch content of non-infested whole, broken grains and flour at 0 day which acted as control.

Per cent loss/gain in protein and sugar contents were calculated with the help of following formulae:

$$\text{Per cent loss} = \frac{\text{Content in uninfested grains/flour - Content in infested grains/flour}}{\text{Content in uninfested grains/flour}} \times 100$$

Per cent gain in reducing sugars was calculated by:

$$\text{Per cent gain} = \frac{\text{Content in infested grains/flour - Content in uninfested grains/flour}}{\text{Content in infested grains/ broken/flour}} \times 100$$

Statistical analysis

Under completely randomized block design, critical difference (CD) was calculated for *S. nesbitti* population on whole grains, broken grains and flour of chickpea using OPSTAT software. Two factorial ANOVA was applied on comparative evaluation of *S. nesbitti* population on three forms of *Desi* channa and changes in biochemical parameters at different durations.

RESULTS AND DISCUSSION

Comparative evaluation of *Desi* channa forms against mites

Exposure of *Desi* channa forms, whole, broken grains and flour to *S. nesbitti* population was compared during monthly data analysis.

Between the three forms, *Desi* channa flour harboured significantly more number of mites (4226.00 mites/g channa) than broken (2478.66 mites/g channa) and whole grains (260.00 mites/g channa) (Fig 1). Irrespective of forms, maximum number of mites was recorded in flour form at 180 days which showed significant difference with mite numbers at other durations. Significant interaction was observed between observation period and *Desi* channa form meaning that statistically lower mite count was recorded in whole grains at all observation periods as compared to broken and flour form. Singh (1990) observed that under optimum conditions, *S. nesbitti* population show exponential growth till the exhaustion of food. The present study corroborated the earlier work on *S. nesbitti* population on pearl millet (Seema, 2020) and cowpea (Dalal, 2020) where continuous increase in *S. nesbitti* population was noticed with increase in duration of infestation.

Due to mite infestation on *Desi* channa, progressive discolouration of whole grains was recorded. During later stages at 180 days, fungal growth appeared which completely damaged the grains. Progressive blackening of broken grains and flour of *Desi* channa was witnessed with increase in observation period. All the three forms; whole, broken grains and flour were emitting characteristic pungent odour. Broken grain material and flour of *Desi* channa became darker in colour as the population multiplied due to excessive excreta at 150 and 180 days. Earlier studies have concluded that flour provides much larger surface area to mites (Kohli and Mathur, 1994) and act as perfect medium for the mite growth (Mahgoob *et al.,* 2006).

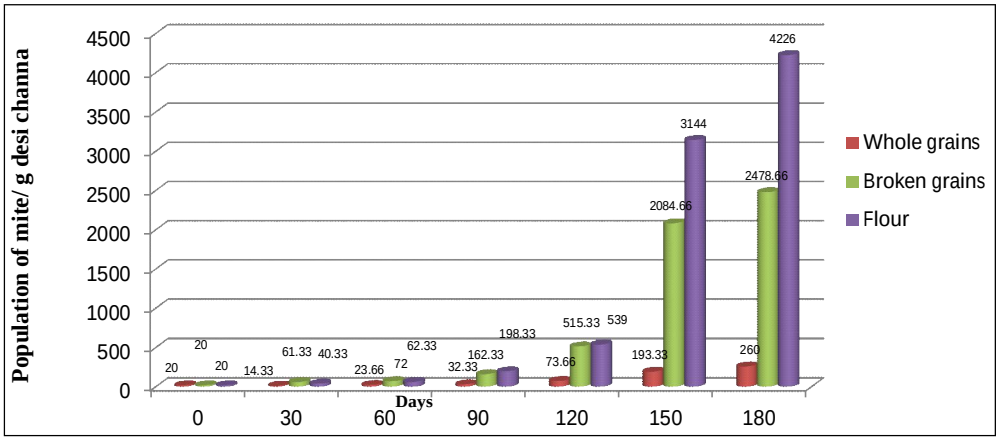

Fig 1: The population of *Suidasia nesbitti* in different *Desi* channa forms.

Qualitative losses in mite infested Bengal gram variety *Desi* channa

The mite, *S. nesbitti* was allowed to feed on whole, broken and flour of chickpea variety *Desi* channa in a separate set of experiment. The qualitative parameters, *viz*., monthly changes in protein and sugars were estimated following standard methodology under completely randomized block design at 0, 90 and 180 days.

Crude protein content in *S. nesbitti* infested *Desi* channa

During present study, crude protein content of *Desi* channa decreased significantly with increase in observation period. At 0 day, amount of crude protein was recorded as highest (154.45 mg/g) which significantly decreased at 90 (149.33 mg/g) and 180 (149.57 mg/g) days; the latter two values being statistically at par with each other (CD=0.39; p=0.05) (Table 1). Statistically lower amount of crude protein (150.27 mg/g) was recorded in the broken grains as compared to whole grains (150.97 mg/g) and flour (152.11 mg/g) (CD=0.37; p=0.05). The ANOVA revealed a significant interaction between observation period and *Desi* channa forms (CD=0.68; p=0.05). It showed significantly less protein content in un infested grains/flour (0 day) as compared to infested grains/ flour of 90 and 180 days. Due to *S. nesbitti* infestation, continuous corresponding decrease in protein content of pearl millet (Seema, 2020) and cowpea (Dalal, 2020) was also reported. Seema (2020) recorded that as the mite number increased to 662.00 mites/5 g grain and 698.00 mites/5 g flour, protein content decreased to 106.133 mg/g in grain and 87.733 mg/g in flour of pearl millet after 180 days.

Total soluble sugars content in *S. nesbitti* infested *Desi* channa

Concurrent with the results of crude protein, maximum amount of total soluble sugars content (10.52 mg/g) was recorded in whole grains, which was significantly higher (CD= 0.04; p=0.05) than the total soluble sugars content recorded in broken grains (10.31 mg/g) and flour (10.01 mg/g) (Table 2). Irrespective of *Desi* channa form, observation period had a significant effect on the total soluble sugars (CD= 0.06; p=0.05). It was recorded as 10.92 mg/g at 0 day which decreased significantly to 10.59 and 9.32 mg/g at 90 and 180 days. Interaction between the observation period and *Desi* channa form was also significant (CD= 0.11; p=0.05) which showed that total soluble sugar content recorded in all the three forms of *Desi* channa differed significantly with each other. It was in the range of 8.64 mg/ g flour at 180 day in flour to 10.92 mg/g at 0 day in all the three forms. Arvind *et al.* (2016) reported that total soluble sugar content decreased from 67.16 mg/g wheat (control) to 60.60 mg/g, after 180 days *Tyrophagus putrescentiae* infestation. Seema (2020) also stated that *S. nesbitti* infestation decreased the total soluble sugar content from 23.100 to 22.100 mg/g in grain form and 23.100 to 21.067 mg/g in flour form of pearl millet.

Reducing sugars content in *S. nesbitti* infested *Desi* channa

In contrast with the results on total soluble sugars, reducing sugars revealed a marked increase with increase in observation period of mite infested grains/ flour. With increase in observation period, a significant corresponding increase from 4.61 mg/g *Desi* channa at 0 day to 4.93 and 5.16 mg/g at 90 and 180 days, respectively (CD=0.09; p=0.05) (Table 3) in reducing sugars was recorded. Statistically lower amount of reducing sugars (4.76 mg/g) was observed in whole grains as compared to 4.94 mg/g in

Table 1: Evaluation of protein content in *Suidasia nesbitti* infested *Desi* channa.

Observation period (days)	Crude protein content (mg/g)			Mean
	Whole grains	Broken grains	Flour	
0	154.45	154.45	154.45	154.45
90	150.10	149.65	148.24	149.33
180	148.37	146.70	153.65	149.57
Mean	150.97	150.27	152.11	

CD (p=0.05) for observation period=0.39; SE(m)=0.13.
CD (p=0.05) for *Desi* channa form=0.37; SE(m)=0.13.
CD (p=0.05) for observation period×*Desi* channa form=0.68; SE(m)=0.23.

Table 2: Evaluation of total soluble sugar content in *Suidasia nesbitti* infested *Desi* channa.

Observation period (days)	Total soluble sugars (mg/g)			Mean
	Whole grains	Broken grains	Flour	
0	10.92	10.92	10.92	10.92
90	10.66	10.64	10.47	10.59
180	9.97	9.36	8.64	9.32
Mean	10.52	10.31	10.01	

CD (p=0.05) for observation period=0.06; SE(m)=0.02.
CD (p=0.05) for *Desi* channa form=0.04; SE(m)=0.01.
CD (p=0.05) for observation period×*Desi* channa form=0.11; SE(m)=0.03.

Table 3: Evaluation of reducing sugar content in *Suidasia nesbitti* infested *Desi* channa.

Observation period (days)	Reducing sugars (mg/g)			Mean
	Whole grains	Broken grains	Flour	
0	4.61	4.61	4.61	4.61
90	4.74	5.00	5.05	4.93
180	4.94	5.21	5.34	5.16
Mean	4.76	4.94	5.00	

CD (p=0.05) for observation period=0.09; SE(m)=0.03.
CD (p=0.05) for *Desi* channa form=0.05; SE(m)=0.02.
CD (p=0.05) for observation period×*Desi* channa form=0.16; SE(m)=0.05.

broken grains and 5.00 mg/g in flour form (CD= 0.05; p= 0.05). The ANOVA revealed a significant interaction between observation period and *Desi* channa forms (CD= 0.16; p= 0.05). It showed significantly higher reducing sugars at 180 days in all the three *Desi* channa forms than at 0 and 90 days. Reducing sugars showed a significant increase from 4.61 to 4.74 and 4.94 mg/g whole grains at 0 to 90 and 180 days. Similar trend was noticed in broken grains (4.61 to 5.00 and 5.21 mg/g) and flour form (4.61 to 5.05 and 5.34 mg/g) in these durations. In earlier studies also, similar trend was witnessed. In pearl millet, the increase in reducing sugars due to *S. nesbitti* was 9.0 to 9.1 mg/g in grains and flour (Seema, 2020). Dalal (2020) observed that in cowpea, increase in *S. nesbitti* population led to increase in reducing sugars from 5.57 to 5.82 mg/g in whole grains, 5.57 to 6.13 mg/g in broken grains and 5.57 to 6.34 mg/g in flour from 0 to 180 days of infestation.

Non-reducing sugars in *S. nesbitti* infested *Desi* channa

The effect of *S. nesbitti* incidence on non-reducing sugars content of *Desi* channa is presented in Table 4. Maximum amount of non-reducing sugars (6.06 mg/g) was recorded in whole grains, which was significantly higher (CD=0.16; p=0.05) than the non-reducing sugars recorded in broken grains (5.90 mg/g) and flour (5.77 mg/g). Irrespective of *Desi* channa forms, observation period had a significant effect on the non-reducing sugar content (CD=0.12; p=0.05). It significantly decreased from 6.31 mg/g in the control (0 day) to 5.91 at 90 days and 5.51 mg/g at 180 days. Interaction between the observation period and *Desi* channa forms was also significant (CD=0.21; p=0.05) which showed that non-reducing sugar content recorded in mite infested grains/ flour differed significantly with each other during quarterly analysis. It was calculated as 6.11 and 5.76 mg/g in whole grains, 5.93 and 5.46 mg/g in broken grains and 5.68 and 5.32 mg/g in flour after 90 and 180 days of observational period as compared to 6.31 mg/g at 0 day.

Starch content in *S. nesbitti* infested *Desi* channa

Changes in the starch content of whole, broken grains and flour of *Desi* channa at different durations of mite infestation were also evaluated during the study (Table 5) which showed a significant effect of observation periods on starch content of *Desi* channa. The initial starch content in *Desi* channa grains was 426.86 mg/g at 0 day which was highest during the present study. When mites were allowed to feed on *Desi* channa, the starch contents decreased to 421.55 and 418.96 mg/g after 90 and 180 days (CD=0.16; p=0.05). The starch content exhibited a marked decrease in flour form (421.67 mg/g) than in broken grains (422.41 mg/g) and whole grains (423.28 mg/g) showing significant effect of form of *Desi* channa (CD=0.19; p=0.05). Interaction between the observation period and *Desi* channa form depicted significant difference in starch content during tri monthly sampling of grains/flour (CD=0.29; p=0.05). It significantly decreased from 426.86 mg/g at 0 day to 422.74 and 420.26 mg/g in whole grains, 421.25 and 419.11 mg/g in broken grains, 420.65 and 417.51 mg/g in flour at 90 and 180 days. Arvind *et al.* (2016) reported that starch content decreased from 444.18 to 367.35 mg/g in wheat after 180 days of *T. putrescentiae* infestation. Seema (2020) also stated that *S. nesbitti* infestation decreased the starch content from 597 to 545.1 mg/g in pearl millet grain and 597 to 468.1 mg/g in flour at 180 days.

During present study, Bengal gram variety, *Desi* channa was susceptible to *S. nesbitti.* In *Desi* channa, the protein content decreased to 148.373 and 146.703 mg/g in whole, broken grains and increased to 153.657 mg/g in flour after 180 days. Low protein content in whole and broken grains of Bengal gram due to the preferential consumption of the embryo (rich in protein) by the mites. The reason for increase in protein content of infested flour can be attributed to high amount of excreta accumulated in the petri dishes with rise in *S. nesbitti* population and presence of skin casts of mites. Earlier Swaminathan (1977) also concluded that this increase in nitrogen content after higher levels of mite infestation is due to higher excretion of uric acid in wheat, caste skins, body fragments and excreta of the mites. Singh (1990) reported that at infestation level of 2000 and 2500 *S. nesbitti* mites/10 g grain, there was increase in protein content of wheat, pearl millet and chickpea. Mites need soluble sugars for their growth and multiplication.

Table 4: Evaluation of non-reducing sugar content in *Suidasia nesbitti* infested *Desi* channa.

Observation period (days)	Non reducing sugars (mg/g)			Mean
	Whole grains	Broken grains	Flour	
0	6.31	6.31	6.31	6.31
90	6.11	5.93	5.68	5.91
180	5.76	5.46	5.32	5.51
Mean	6.06	5.90	5.77	

CD (p=0.05) for observation period=0.16; SE(m)=0.02.
CD (p=0.05) for *Desi* channa form=0.12; SE(m)=0.04.
CD (p=0.05) for observation period×*Desi* channa form=0.21; SE(m)=0.07.

Table 5: Evaluation of starch content in *Suidasia nesbitti* infested *Desi* channa.

Observation period (days)	Starch content (mg/g)			Mean
	Whole grains	Broken grains	Flour	
0	426.86	426.86	426.86	426.86
90	422.74	421.25	420.65	421.55
180	420.26	419.11	417.51	418.96
Mean	423.28	422.41	421.67	

CD (p=0.05) for observation period=0.16; SE(m)=0.05.
CD (p=0.05) for *Desi* channa form=0.19; SE(m)=0.06.
CD (p=0.05) for observation period×*Desi* channa form=0.29; SE(m)=0.09.

These sugars are formed due to the hydrolysis of starch and other polysaccharides present in the food. Mites feed on these sugars which led to significant decrease in the total soluble sugar, non-reducing sugar and starch as reported in the earlier studies done by several workers. The trend in reducing sugars was different from the trends witnessed with other sugars mentioned above. The results showed percent increase in reducing sugars as *S. nesbitti* population increased. Reducing sugar increase as the mite infestation increase, due to the hydrolysis of starch resulting in more release and concentration of soluble sugar (Anita, 2010). In wheat, with increase in mite infestation, reducing sugars also increased from 24.10 to 27.65 mg/g at 180 days of infestation (Arvind *et al.*, 2016). Kumar, 2017 also observed the increase in the reducing sugar content in pearl millet grains and flour at 180 days of *T. putrescentiae* infestation.

CONCLUSION

Mites are important pests in stored grain products due to the damage caused by their feeding. Present study revealed significant negative impacts of *S. nesbitti* [Hughes] on Quantitative and Qualitative aspects in Chickpea var. *Desi* Channa. Qualitative estimation of infested grains revealed the decrease in total soluble sugars [9.32 mg/g], non-reducing sugars [5.51 mg/g] and starch [418.96] after 180 days of infestation, respectively as compared to 10.92 mg/g, 6.31 mg/g and 426.86 mg/g at 0 day; showing significant negative correlation. However, the reducing sugars increase from 4.61 mg/g at 0 day to 4.93 and 5.16 mg/g at 90 and 180 days of mite exposure, showing significant positive correlation. Management of stored grains done by: managing temperature and aeration, use of chemical protectants, Plant-derived extracts and essential oils.

Conflict of interest

All authors declare that they have no conflict of interest.

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