Plant Archives Vol. 26, Supplement 2, 2026 pp. 2643-2648 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.333

IMPACT OF DIFFERENT TYPES OF PACKAGING BAGS AGAINST CIGARETTE BEETLE, *Lasioderma serricorne* (FABRICIUS), INFESTING FENNEL SEEDS

Patel A.J.[1*] and Dand J.J.[2]
[1]Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand-388 110, Gujarat, India
[2]AINP on VPM: Agricultural Ornithology, ICAR Unit- 9, Anand Agricultural University, Anand-388 110, Gujarat, India.
*Corresponding author E-mail: patel08anjali03@gmail.com
(Date of Receiving : 30-04-2026; Date of Revision : 16-06-2026; Date of Acceptance : 06-07-2026)

ABSTRACT

The packaging materials, namely gunny bag, cotton cloth bag, brown paper bag, HDPE woven bag and polythene bag showed considerable variation in cigarette beetle adult emergence, seed damage based on the number of damaged seeds, weight of damaged seeds and weight loss during 2.5month storage. The highest adult emergence was recorded in gunny bag (321.13 adults) followed by cotton cloth bag (281.57 adults), brown paper bag (247.12 adults) and HDPE woven bag (237.16 adults), whereas the lowest adult emergence was observed in polythene bag (101.40 adults). Seed damage based on the number of damaged seed was maximum in gunny bag (60.22%) followed by cotton cloth bag (59.73%), brown paper bag (54.56%) and HDPE woven bag (35.45%), while the minimum seed damage was recorded in polythene bag (18.94%). Likewise, the weight of damaged seeds per 100 seeds was highest in gunny bag (285.27 mg) followed by cotton cloth bag, brown paper bag and HDPE woven bag, whereas the lowest weight of damaged seeds was observed in polythene bag (126.79 mg). Weight loss of fennel seeds after two and half months of storage was maximum in gunny bag (22.53%) followed by cotton cloth bag (21.12%), brown paper bag (18.30%) and HDPE woven bag (14.08%), while the minimum weight loss was recorded in polythene bag (11.26%). Based on adult emergence, seed damage and weight loss, the effectiveness of packaging materials in reducing infestation followed the order: polythene bag > HDPE woven bag > brown paper bag > cotton cloth bag > gunny bag. Additionally, a greater number of holes caused by *L. serricorne* infestation were observed in cotton cloth bags and brown paper bags while gunny bags did not exhibit distinct holes but cigarette beetles enter through space between the knitted during storage indicating their higher susceptibility to beetle penetration and damage. In contrast, the fewest holes were observed in polythene bags and HDPE woven bags, suggesting that these packaging materials provided better protection against *L. serricorne* infestation and penetration.

Keywords **:** Packaging bags, cigarette beetle, *Lasioderma serricorne*, Fennel (*Foeniculum vulgare* Mill.).

Introduction

Fennel (*Foeniculum vulgare* Mill.), popularly known as saunf, belongs to the Apiaceae family (Rather *et al*., 2016). The term fennel is derived from the Latin word Foeniculum, meaning "little hay," referring to its slender, hay-like foliage and pleasant aroma. It is considered native to the Mediterranean region (Khan & Musharaf, 2014) and now cultivated worldwide, with India leading production, especially in Gujarat, Rajasthan and Uttar Pradesh. The state of Gujarat holds a significant position in the spice production of India by being a major processing, trading and export hub of Seed Spices. Gujarat occupies the second position after Rajasthan in the production of fennel in India. (Anonymous, 2024a). Fennel growing districts in Gujarat include Mehsana, Patan, Banaskantha, Sabarkantha and Aravalli (Anon., 2024b). In Gujarat, during 2025 fennel was cultivated on 1,00,000 hectares with an annual production of 2,10,000 tonnes (Anon., 2025a).

Fennel is commonly used as a spice in culinary applications and has long been valued in traditional medicine for treating digestive, respiratory, endocrine and reproductive disorders. It is also used to relieve constipation, flatulence, diarrhoea and cough. Fennel contains various bioactive compounds such as volatile oils, flavonoids, phenolics, fatty acids and amino acids, contributing to its pharmacological properties like antimicrobial, anti-inflammatory and cardioprotective effects (Badgujar *et al*., 2014). Additionally, it shows hepatoprotective, hypoglycaemic, hypolipidemic, antitumour, analgesic and memory-enhancing activities. It plays a vital role in Ayurvedic medicine and functions as a galactagogue, aiding milk secretion in lactating women (Anubhuti *et al*., 2011). Traditional remedies also include its use in treating snake bites and detoxifying plant poisons (Gori *et al*., 2012).

Fields account for the majority of insect infestation instances, although storehouses are another source. In most cases, the infestation of insects is not noticed until adults are observed. Many seeds have already been harmed by the time these adults are formed. Harvested produce losses can be either qualitative or quantitative and they can happen continuously or separately, approximately 17 to 25 per cent of the spices are lost during storage due to rats, insects and mold. The process of turning seed into powder results in these losses (Malhotra & Vashishtha, 2007). For fennel the cigarette beetle (*Lasioderma serricorne*), drug store beetle (*Stegobium paniceum* L.) and seed wasp (*Systole albipennis*) are the most frequent pests that infest seed spices while they are being stored. Rice moth (*Corcyra cephalonica*), almond moth (*Cadrac autella*) and red rust flour beetle (*Tribolium castaneum*) are found to infest these stored spices (Kant *et al*., 2022). Among these, the cigarette beetle (*L. serricorne*) is a major pest that attacks all the spices under storage invariably (Chaudhari *et al*., 2021). The cigarette beetle has caused considerable damage in fennel leading to losses of 58.02 per cent (Kant *et al*., 2013).

Such an important seed spice is highly susceptible to infestation by storage pests, particularly the cigarette beetle. The cigarette beetle poses a major threat to stored agricultural products, causing quantitative and qualitative losses during post-harvest storage due to its ability to bore into packaging materials and infest stored seeds, especially in warm and humid climates. Conventional chemical control methods, such as fumigation and insecticides, carry risks to human health and can result in harmful residue accumulation in food products. Consequently, there is growing interest in safer and more sustainable pest management strategies, including the use of physical barriers such as improved packaging materials. Insect resistant packaging is the most common way to prevent insect infestation without using insecticides or repellents (Mullen & Highland, 1988). The materials like jute, cloth, High Density Polyethylene (HDPE) and laminated multilayer packaging vary in their ability to prevent infestation. Therefore, evaluating the efficacy of different packaging bag materials in managing *L. serricorne* in stored fennel seeds is essential to ensure product quality, reduce chemical dependency and support an eco-friendly, cost-effective storage solution for seed spice preservation and post-harvest pest management.

Materials and Methods

Rearing of *L. serricorne*

Adult beetles required for the initiation of culture were obtained from the ornithology laboratory (identified as *L. serricorne*) stock culture. Approximately 30 adults were released into plastic jars (19 cm height × 10 cm diameter) containing 500 gm of coriander seeds previously sterilized at 50 °C for 4 hours in a hot air oven to eliminate any prior infestation. The jars were tightly covered with lids to prevent the escape of insects and to maintain suitable conditions. In addition, separate plastic jars (6.3 cm height × 6.5 cm diameter) containing the insect culture in fennel seeds were maintained under laboratory conditions for continuous multiplication and uniform population growth. The seeds were replaced at monthly intervals with fresh, undamaged and sterilized seeds to ensure proper rearing conditions. The culture was maintained throughout the experimental period and the adults obtained from it were used for studies on management of *L. serricorne*.

Packaging material and experimental setup

An experiment on the evaluation of various packaging materials against infestation of cigarette beetle, *L. serricorne*, in fennel seeds was conducted at AINP on VPM, Agricultural Ornithology, ICAR Unit-9, AAU, Anand during January to April, 2026. Given the damage caused by *L. serricorne*, it was essential to manage the cigarette beetle using non-chemical methods, such as different packaging materials. Packaging materials act as a physical barrier and can influence the extent of insect infestation during storage. Seeds of fennel were procured from Seed Spices Research Station, SDAU, Jagudan.

Table 1: Experimental Details

1.	**Location**	AINP on VPM, Agril. Ornithology, AAU, Anand	
2.	**Year**	2026	
3.	**Design**	Completely Randomized Design (CRD)	
4.	**Seed spice and variety**	Fennel (Gujarat Fennel 12)	
	Treatments	5	
		Tr. No.	**Packaging material**
		T_1	Gunny bag
		T_2	Cotton cloth bag
		T_3	Brown paper bag
		T_4	HDPE woven bag
		T_5	Polythene bag
5.	**Repetitions**	4	

The study was carried out under laboratory conditions and five types of bags prepared from different materials were chosen for the study, i.e., gunny bag, cotton cloth bag, brown paper bag, HDPE woven bag and polythene bag (Fig 1). Each bag contained 250 g of fennel (previously sterilized in the oven at 50 ˚C for 4 hrs) and was carefully sealed for evaluation of different type of packaging bags against cigarette beetle, *L. serricorne* infesting fennel seeds.

Fig. 1: Different types of packaging bags

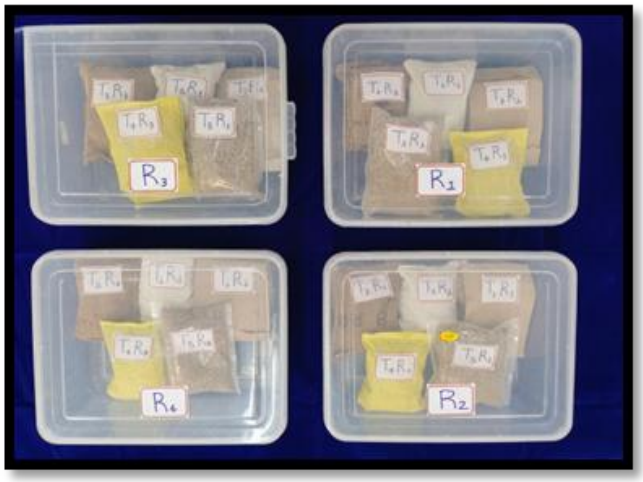

Fig. 2: Different packaging bags placed in plastic container

All five bags with different materials were kept in a plastic container and repeated four times (Fig. 2). Fifty newly emerged beetles (2 or 3 days old) were released in each container. After 2.5 months, the container was opened and the number of live and dead insect inside and outside the bag were counted. From the commodity, 100 seeds were randomly selected and healthy as well as damaged seeds were counted. The seed damage (%) on the basis of the number of seeds was calculated by counting the number of damaged seeds out of randomly selected hundred seeds after two and a half months of storage. The weight of damaged seeds out of a hundred seeds per bag 33 Material and Methods was also recorded. The percent loss in weight of each bag after storage is calculated by the following formula (Boxall, 1986):

$$\text{Weight loss} = \frac{(M_1 - M_2)}{M_1} \times 100$$

M_1 = Weight of the hundred seeds before storage

M_2 = Weight of a hundred seeds after storage

Statistical Analysis

The data on the total number of adults emerged after two and a half months of storage, seed damage (%) on the basis of the number damaged seeds per hundred seeds and weight of damaged seeds per hundred seeds were analysed using analysis of variance (ANOVA). Before analysis, the data on the total number of adults emerged after two and a half months of storage and the weight of damaged seeds per hundred seeds were transformed using the square root transformation while seed damage (%) based on the number of damaged seeds per hundred seeds was transformed using the arcsine transformation.

Result and Discussion

Total Number of Adults Counted after Two and Half Months of Storage

The data on the total number of adult cigarette beetles that emerged during two and half months of storage under different packaging materials are presented in Table 2. Among the evaluated packaging materials, the gunny bag recorded the highest adult emergence with a mean value of 321.13 adults followed by the cotton cloth bag and brown paper bag, which recorded mean adult populations of 281.57 and 247.12 adults, respectively. Comparatively lower adult emergence was observed in the HDPE woven bag, which recorded 237.16 adults during the storage period. The minimum population growth of cigarette beetle was observed in the polythene bag, where only 101.40 adults emerged after two and half months of storage.

The results obtained in the present study are in agreement with the findings of Akshaya (2025), who also observed variation in cigarette beetle population growth among different packaging materials during storage of coriander seeds. The study indicated the lowest adult emergence in polythene bag followed by HDPE woven bag and brown paper bag, whereas comparatively higher adult emergence was recorded in cotton cloth bag and gunny bag. Since a larger number of holes were observed in cotton cloth bags and brown paper bags due to *L. serricorne*, these packaging materials were more susceptible to beetle penetration. In contrast, distinct holes were not observed in gunny bags, as the cigarette beetles entered through the spaces between the knitted indicating their comparatively higher vulnerability to infestation and damage. The fewest holes were observed in polythene and HDPE woven bags, indicating better resistance to *L. serricorne* penetration.

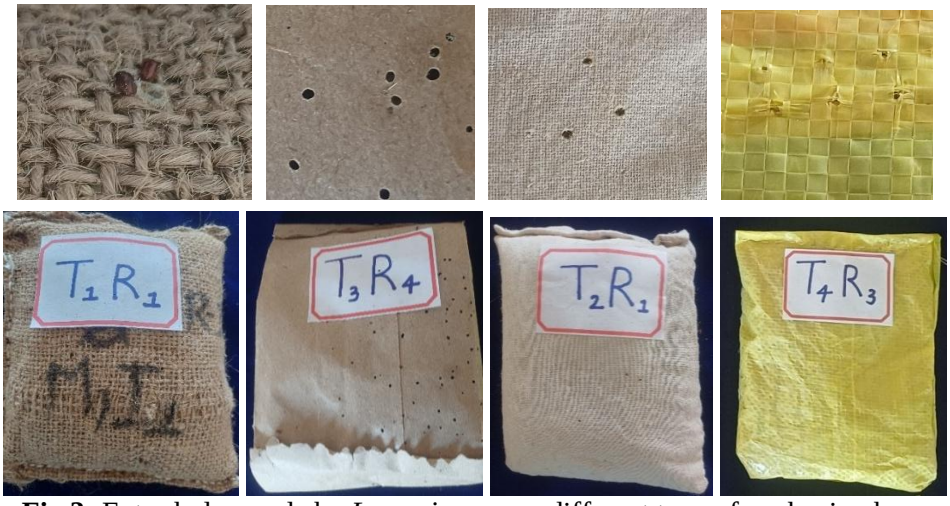

Fig 3: Entry holes made by *L. serricorne* on different type of packaging bags

Seed Damage on the Basis of Number Damaged Seeds (%)

The data on the number of damaged seeds recorded from a randomly selected sample of one hundred fennel seeds after two and a half months of storage showed considerable variation among the different packaging materials (Table 2). Among the treatments, the highest seed damage was recorded in the gunny bag with 60.22 per cent damaged seeds. This was closely followed by cotton cloth bag and brown paper bag, which recorded seed damage of 59.73 and 54.56 per cent, respectively. Comparatively lower seed damage was observed in the HDPE woven bag, which recorded 35.45 per cent damaged seeds during the storage period. The minimum seed damage was observed in the polythene bag with only 18.94 per cent damaged seeds after two and a half months of storage.

Akshaya (2025) also reported differences in seed damage caused by cigarette beetle in coriander seeds stored under various packaging materials. The study revealed comparatively higher seed damage in gunny and cotton cloth bags, while lower seed damage was observed in HDPE woven and polythene bags. Among all the packaging materials evaluated, the least seed damage was noticed in polythene bag.

Table 2: Evaluation based on population growth of cigarette beetle and weight loss in different packaging bags

Tr. No.	Packaging material	Total number of adults emerged after 2.5 month	Seed damage		Weight of 100 seeds before adult released (mg)	Weight of 100 seeds after 2.5 months of adult released (mg)	Weight loss (%)
			Based on the number of damaged seeds per 100 seeds (%)	Based on weight of damaged seeds per 100 seeds (mg)			
T_1	Gunny bag	17.92* (321.13)	50.90** (60.22)	16.89* (285.27)	710	550	22.53
T_2	Cotton cloth bag	16.78* (281.57)	50.61** (59.73)	16.34* (266.99)	710	560	21.12
T_3	Brown Paper bag	15.72* (247.12)	47.56** (54.56)	16.12* (259.85)	710	580	18.30
T_4	HDPE woven bag	15.40* (237.16)	36.54** (35.45)	13.03* (169.78)	710	610	14.08
T_5	Polythene bag	10.07* (101.40)	25.80** (18.94)	11.26* (126.79)	710	630	11.26
S. Em. ±		0.35	0.84	0.33	-	6.36	-
C.D. at 5%		1.06	2.53	0.99	-	20.63	-
C.V. (%)		4.64	3.97	4.45	-	2.34	-

Notes: 1. *Figures outside the parentheses are square transformed values and those inside the parentheses are retransformed values
2. **Figures outside the parentheses are arcsine transformed values and those inside the parentheses are retransformed values

Weight of Damaged Seeds (mg)

The data on the weight of damaged seeds per hundred seeds after two and a half months of storage are presented in Table-2. The results revealed noticeable variation in weight of damaged seeds among the different packaging materials evaluated against cigarette beetle infestation in stored fennel seeds. Among the packaging materials tested, the highest weight of damaged seeds was recorded in the gunny bag with a mean value of 285.27 mg followed by cotton cloth bag and brown paper bag, which recorded damaged seed weights of 266.99 mg and 259.85 mg, respectively. Comparatively lower weight of damaged seeds was observed in HDPE woven bag, which recorded 169.78 mg after the storage period. The minimum weight of damaged seeds was recorded in the polythene bag with 126.79 mg after two and half months of storage.

The present findings are in close conformity with the observations of Akshaya (2025), who studied seed damage caused by cigarette beetle in stored coriander seeds under different packaging materials. The study demonstrated that the level of seed damage differed according to the type of packaging used, with comparatively higher damage associated with gunny, cotton cloth and brown paper bags, while lower damage was observed in HDPE woven and polythene bags.

Weight Loss (%)

The weight loss per cent of fennel seeds stored for two and half months is presented in Table 2. Among the treatments the highest weight loss was recorded in fennel seeds stored in gunny bags with a value of 22.53 per cent. This was followed by cotton cloth bag, which recorded 21.12 per cent weight loss. Fennel seeds stored in brown paper bag exhibited a weight loss of 18.30 per cent, while HDPE woven bag recorded comparatively lower weight loss of 14.08 per cent. The minimum weight loss was observed in fennel seeds stored in polythene bag with a value of 11.26 per cent after two and half months of storage.

Nehra *et al*. (2021) also reported the effectiveness of different packaging materials against pulse beetles, where polyethylene bags proved to be the most effective followed by cloth cotton bags, while jute bags exhibited the least effectiveness. Similar observations were also recorded by Hassan *et al*. (2024), wherein the lowest population density of cigarette beetle was observed in polyethylene bags followed by craft paper packaging. The observations recorded in the present investigation are comparable with the findings reported by Akshaya (2025), who evaluated weight loss in stored coriander seeds under different packaging materials infested by cigarette beetle.

Conclusion

Laboratory evaluation of different packaging materials for the storage of fennel seeds against cigarette beetle infestation revealed significant variation among the treatments with respect to insect multiplication and seed damage. Based on total adult emergence after two and half months of storage, polythene bag (101.40 adults) recorded the lowest

population of *L. serricorne*, whereas gunny bag (321.13 adults) showed the highest adult emergence. The increasing order of adult emergence among the packaging materials was: polythene bag (101.40 adults) < HDPE woven bag (237.16 adults) < brown paper bag (247.12 adults) < cotton cloth bag (281.57 adults) ≤ gunny bag (321.13 adults). The results indicated that the polythene bag was comparatively more effective in restricting population development of the cigarette beetle during storage.

Seed damage percentage based on the number of damaged seeds per hundred seeds also differed considerably among the packaging materials. The highest seed damage was observed in gunny bag (60.22%) followed by cotton cloth bag (59.73%) and brown paper bag (54.56%), whereas the lowest seed damage was recorded in polythene bag (18.94%). The increasing order of seed damage among the packaging materials was: Polythene bag (18.94 %) < HDPE woven bag (35.45 %) < Brown paper bag (54.56 %) < Cotton cloth bag (59.73 %) ≤ Gunny bag (60.22%).

Similarly, the weight of damaged seeds per hundred seeds was highest in gunny bag (285.27 mg) and lowest in polythene bag (126.79 mg). The increasing order for weight of damaged seeds was: polythene bag (126.79 mg) < HDPE woven bag (169.78 mg) < brown paper bag (259.85 mg) < cotton cloth bag (266.99 mg) < gunny bag (285.27 mg).

Weight loss in fennel seeds after 2.5 months of storage was lowest in polythene bags (11.26%), followed by HDPE woven bags (14.08%), brown paper bags (18.30%), cotton cloth bags (21.12%) and gunny bags (22.53%). Thus, the increasing order of weight loss was: polythene bag (11.26%) < HDPE woven bag (14.08%) < brown paper bag (18.30%) < cotton cloth bag (21.12%) < gunny bag (22.53%). The findings indicated that packaging materials greatly influenced the infestation and damage caused by *L. serricorne* in stored fennel seeds. Among the evaluated packaging bags, the polythene bag proved the most effective in minimizing adult emergence and seed damage, thereby offering better protection during storage. In contrast, gunny bag was found the least effective packaging material against cigarette beetle infestation.

References

Akshaya, V. T. (2025). *Comparative biology and management of cigarette beetle, Lasioderma serricorne* (F.) *infesting stored coriander seed*. (Master's thesis, Anand Agricultural University, Anand, Gujarat).

Anonymous (2024a). Spice Board India Ministry of Commerce and Industry, Govt. India Retrieved from: https://www. indianspices.com/trade /bsm_ archive /16 _Gujarat .pdf. Retrieved on: 21st April, 2025

Anonymous (2024b). Anand Agricultural University. Retrieved from: https://www. aau. In /site s /default/files/book1.pdf. Retrieved on: 30th May, 2025

Anonymous (2025a). Spice Board India. Retrieved from: www.indianspices.com Retrieved on: 30th May, 2025.

Anubhuti, P., Rahul, S., & Kant, C. K. (2011). Standardization of fennel (*Foeniculum vulgare*), Its oleoresin and marketed ayurvedic dosage forms. *International Journal of Pharmaceutical Sciences and Drug Research*, **3**(3), 265-269.

Badgujar, S. B., Patel, V. V., & Bandivdekar, A.H. (2014). *Foeniculum vulgare* Mill: A Review of Its botany, phytochemistry, pharmacology, contemporary application and toxicology. *BioMed Research International*, (1), 1-32. DOI: https://doi.org/10.1155/2014/842674

Boxall, R. A. (1986). *A critical review of the methodology for assessing farm-level grain losses after harvest, London. Tropical development and research institute publishing.*

Chaudhari, N. J., Muralidharan, C. M., Joshi, M. K. J., & Solanki, C. B. (2021). Assessment of storage losses due to *Lasioderma serricorne* F. on seed spices. *Indian Journal of Entomology*, **83** (3), 397-400.

Gori, L., Galluzzi, P., Mascherini, V., Mugelli, A., Vannacci, A., & Firenzuoli, F. (2012). Can estragole in fennel seed decoctions really be considered a danger for human health? A fennel safety update. *Evidence-Based Complementary and Alternative Medicine*, **2012** (1), 860542. DOI: https://doi.org/10.1155/2012/8 60542

Hassan, W. F., & Zinhoum, R. A. (2024). Influence of pest infestation, type of packages and different storage periods on seeds and essential oil composition of coriander, *Coriandrum sativum* L. Family: Apiaceae. *Egyptian Journal of Chemistry*, **67**(2), 321-337.

Kant, K., Meena, S. R., Devasahayam, S., & Mani, M. (2022). Storage pests and their management in spices. Trends in Horticultural Entomology. Singapore, Springer.

Kant, K., Ranjan, J. K., Mishra, B. K., Meena, S. R., Lal, G., & Vishal, M. K. (2013). Post-harvest storage losses by cigarette beetle (*Lasioderma serricorne* Fab.) in seed spice crops. *Indian Journal of Horticulture*, **70** (3), 392-396.

Khan, M., & Musharaf, S. (2014). *Foeniculum vulgare* Mill. A medicinal herb. *Medicinal Plant Research*, **4** (6), 46-54.

Malhotra, S. K., & Vashishtha, B. B. (2007). Production, development, quality and export of seed spices. Ajamer, Rajasthan: National Research Centre on Seed Spices.

Mullen, M. A., & H. A. Highland. (1988). Package defects and their effect on insect infestation of instant dry non-fat milk. *Journal of Packaging Technology*, **2**, 266-267.

Nehra, S., Lekha, H. S., & Chhangani, G. (2021). Assessment of various packaging materials for pulse storage against pulse beetle (*Callosobruchus chinensis* L.). *The Pharma Innovation Journal*, **10**(9), 554-558.

Rather, M. A., Dar, B. A., Sofi, S. N., Bhat, B. A., & Qurishi, M. A. (2016). *Foeniculum vulgare*: A comprehensive review of its traditional use, phytochemistry, pharmacology and safety. *Arabian Journal of Chemistry*, **9**, 574-583.