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PJMLS OPEN ACCESS
Print ISSN: 2707-4471. Online ISSN: 2707-448X

Research Article	Pak-Euro Journal of Medical and Life Sciences
DOI: 10.31580/pjmls.v8iSp3.3459	Copyright © All rights are reserved by Corresponding Author
Vol. 8 No. Special 3, 2025-26: pp. S207-S214	
www.readersinsight.net/pjmls	**Revised:** March 11, 2026 **Accepted:** March 25, 2026
Submission: December 29, 2025	**Published Online:** March 31, 2026

PREVALENCE AND DISTRIBUTION OF INSECT PESTS IN DRY FRUITS OF QUETTA, BALOCHISTAN, PAKISTAN

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Abstract

The study assessed the prevalence and distribution of insect pests infesting dry fruits in Quetta, Balochistan, over a one-year period from March 2024 to February 2025. Samples of ten major dry fruit types—including figs, cashew nuts, pistachios, dried dates, dried apricots, and black currant raisins—were collected from randomly selected local dry fruit shops in the region. A total of seven major pest species were identified, with 223 individuals recorded across all samples. The overall infestation rate was 49.8%, with Oryzaephilus surinamensis (sawtoothed grain beetle) emerging as the dominant species. Seasonal analysis revealed that pest activity peaked during summer, with the highest infestation levels observed in August. The study also evaluated the effectiveness of various pest management practices, finding chemical control to be the most commonly used method; 65% of vendors reported applying Malathion 57EC. Based on these findings, the study recommends the integration of neem leaves, bay leaves, dry roasting, and salt roasting into Integrated Pest Management (IPM) strategies to improve the protection of stored dry fruits against insect infestations.

Keywords: *Infestation rate, Integrated Pest Management (IPM), Oryzaephilus surinamensis, Sawtoothed grain beetle, Seasonal pest activity, Stored product pests*

INTRODUCTION

Dry fruits are highly susceptible to infestation by a wide range of stored-product insect pests during post-harvest handling, storage, and marketing. Such infestations not only cause physical feeding damage but also lead to significant quality deterioration, often accompanied by contamination from insect fragments, frass, and webbing. These compounded effects result in considerable quantitative losses, ultimately diminishing market value and consumer acceptance (1).

The larval stage is particularly destructive, as larvae actively feed on dry fruit tissues, penetrate kernels, and produce extensive webbing, accelerating product spoilage. The developmental duration and population dynamics of these pests are strongly influenced by environmental factors such as temperature, relative humidity, and food availability. For instance, under optimal conditions, *Oryzaephilus surinamensis* can complete its life cycle within 24 to 40 days, facilitating rapid population buildup in storage systems (2). Similarly, species like *Plodia interpunctella* and *Ephestia* spp. are capable of producing multiple generations per year, with eggs hatching within days and larvae inflicting substantial damage prior to pupation (3). The presence of overlapping generations often leads to persistent and difficult-to-control infestations, particularly in the absence of timely detection and intervention.

The prevalence and distribution of insect pests vary considerably among different types of dried fruits, owing to differences in moisture content, nutritional composition, packaging methods, and storage duration. In Quetta, the local climate—characterized by hot summers—combined with inadequate storage infrastructure in traditional market settings, further exacerbates pest proliferation and reproductive success. Therefore, a comprehensive assessment of the prevalence and distribution of insect pests across various dry fruit commodities and market locations is essential for understanding infestation patterns and identifying high-risk products, thereby informing effective management strategies (4).

Effective pest management in stored dry fruits requires a thorough understanding of not only the pest species involved and their seasonal activity but also the current control practices adopted by vendors

and their relative efficacy. In many local markets, pest control relies heavily on chemical insecticides due to their rapid action, ease of application, and low cost. However, the over-reliance on synthetic chemicals raises serious concerns regarding food safety, human health, environmental contamination, and the potential development of insecticide resistance (5). Moreover, inadequate application techniques and poor storage hygiene often compromise the effectiveness of chemical treatments, leaving room for recurrent infestations. In recent years, there has been growing interest in alternative, eco-friendly approaches such as the use of plant-based repellents, physical treatments like roasting, and improved storage practices. These methods offer promising avenues for integration into broader Integrated Pest Management (IPM) frameworks, which emphasize sustainable, multi-tactic strategies tailored to local conditions (6). Given the scarcity of documented information on pest dynamics and management interventions in the dry fruit supply chain of Quetta, Balochistan, this study was designed to fill that gap by documenting the prevalent insect fauna, seasonal infestation patterns, and currently employed pest control measures, with the ultimate goal of recommending practical, region-specific IPM solutions.

METHODOLOGY

The present study was conducted in Quetta, the provincial capital of Balochistan, Pakistan, over a period of twelve months from March 2024 to February 2025. Sampling was carried out at twenty randomly selected local dry fruit retail shops distributed across three major commercial areas of the city, namely Qandahari Bazar, Liaqat Bazar, and Toghi Road, to ensure representative coverage of the local dry fruit trade.

A total of ten commercially important dry fruit varieties, including figs, cashew nuts, pistachios, dried dates, dried apricots, black currants, and raisins, were sampled from each selected shop. Approximately 500 g of each dry fruit type were collected per shop, amounting to a cumulative sample of 5 kg per establishment. All collected samples were immediately sealed in clean, labeled polythene bags and transported to the Entomology Research Laboratory, Department of Zoology, Sardar Bahadur Khan Women's University Quetta, for further examination and analysis.

Upon arrival, each sample was carefully inspected under a stereomicroscope for the presence of insect pests at all life stages, including adults, larvae, pupae, and eggs. All detected insects were isolated using fine forceps and preserved in sterile glass vials containing 70% ethanol for subsequent identification. Species-level identification was performed using standard dichotomous taxonomic keys following the methodology described by Ebrahimi et al. (2016). For microscopic examination and confirmation of diagnostic morphological characters, permanent slide mounts of identified specimens were prepared in accordance with the protocols outlined by Samejo et al. (2016).

To assess the species diversity and evenness of the collected pest fauna, the Shannon–Wiener diversity index (H′) was calculated using the standard formula:

$$\text{Shannon Index } H = -\sum_{i=1}^{s} pi \, \text{Inpi}$$

where *pi* represents the proportional abundance of the *hith* species, calculated as *ni*/*N* (with *ni* being the number of individuals of a given species and *N* the total number of individuals across all pecies), ln denotes the natural logarithm, and *s* is the total number of species recorded. This index was employed to quantify species richness and relative abundance patterns among the identified insect pests infesting the sampled dry fruits.

RESULTS

A total of 223 individual insect pests were collected from ten varieties of dry fruits sampled across twenty randomly selected local retail shops in Quetta, Balochistan. The collected specimens represented seven distinct species belonging to three families. The identified species included *Oryzaephilus surinamensis* (sawtoothed grain beetle), *Plodia interpunctella* (Indian meal moth), *Tribolium castaneum* (red

flour beetle), *Ephestia cautella* (almond moth), *Ephestia figulilella* (raisin moth), *Cydia pomonella* (codling moth), and *Amyelois transitella* (navel orangeworm).

Among the recorded species, *Oryzaephilus surinamensis* was the most prevalent, accounting for the highest number of individuals (n = 92), followed by *Plodia interpunctella* (n = 53), *Ephestia cautella* (n = 27), *Tribolium castaneum* (n = 16), *Ephestia figulilella* (n = 12), *Amyelois transitella* (n = 12), and *Cydia pomonella* (n = 11). The relative abundance and species composition are summarized in Table I.

Table I. List of specimens observed in dry fruits of randomly selected shops of Quetta

Order	Family	Species (common name)	Total specimen collected
Coleoptera	Silvanidae	*Oryzaephilus surinamensis* (Sawtoothed Grain Beetle)	92
	Tenebrionidae	*Tribolium castaneum* (Red Flour Beetle)	16
Lepidoptera	Pyralidae	*Plodia interpunctella* (Indian Meal Moth)	53
	Pyralidae	*Ephestia figulilella* (Raisin Moth)	12
	Pyralidae	*Ephestia cautella* (Almond Moth)	27
	Pyralidae	*Amyelois transitella* (Noval orange worm)	12
	Tortricidae	*Cydia pomonella* (Codling Moth)	11

A 5 kg composite sample of dried fruits, procured from various shops in Quetta, was examined. The sample comprised ten distinct fruit types, each represented by a 500 g aliquot: fig, cashew nuts, walnuts, almonds, peanuts (earth nuts), dried apricot, dried dates, and black currants. The individual prevalence rates of insect infestation for these selected items were recorded as 50%, 40%, 54%, 50%, 46%, 45%, 54%, 54%, 56%, and 40%, respectively. Overall, the mean insect pest prevalence across the entire 5 kg sample was approximately 49.8% (Table II).

Table II. Prevalence of insect infestation in various dry fruits

S. No.	Dry fruits	Observed	Infested	Prevalence
1	Fig	500g	300g	50%
2	Cashew nuts	500g	200g	40%
3	Wall nut	500g	270g	54%
4	Almond	500g	250g	50%
5	Raisins	500g	230g	46%
6	Earth nuts	500g	230g	45%
7	Pistachio	500g	260g	54%
8	Dried Apricot	500g	270g	54%
9	Dried dates	500g	280g	56%
10	Black current	500g	211g	40%
	Total	5kg	2kg 500g	49.8%

Table III presents the Shannon–Wiener species diversity index for insect pests randomly collected from various dry fruit shops in Quetta, Balochistan. The calculated richness (H′ = 1.69) and evenness (E = 0.81) indicate a moderate level of insect species diversity among the dry fruit samples. Specifically, the diversity index value of 1.6909 reflects a moderately diverse insect pest community in the study area.

Table III. Species richness in dry fruits of Quetta, Balochistan

Month	Average %
March	4.5%
April	6.0%
May	9.2%
June	10.1%
July	12.8%
August	16.9 % (Peak)
September	15.3%
October	9.8%
November	6.2%
December	3.5%
January	1.5%
February	3.1%

The highest insect prevalence occurred in August (16.9%), with a secondary peak in September (15.0%). The remaining months showed progressively lower activity: July (12.8%), June (10.1%), October (9.8%), May (9.2%), November (6.2%), December (3.5%), February (3.1%), and January recording the lowest at 1.5% (Table IV). Overall, the data reveal that more than half of all annual insect activity is concentrated in just three months; July, August, and September; underscoring the seasonal nature of prevalence in this study.

Table IV. Seasonal infestation rate of insects in dry fruits of Quetta, Balochistan

S. No.	Insect species	p	Pi	ln(pi)	Pi(ln(pi))	-pi (ln(pi))
1	*Plodia interpunctella*	53	0.2163	- 1.531	-0.3312	0.3312
2	*Amyelois transitella*	11	0.0449	-3.1034	-0.1393	0.1393
3	*Oryzaephilus surinamensis*	103	0.4204	-0.8665	-0.8665	0.8665
4	*Cydia pomonella*	11	0.0449	-3.1034	-0.1393	0.1393
5	*Ephestia figulilella*	12	0.0490	-3.0164	-0.1007	0.1007
6	*Tribolium castaneam*	16	0.0653	-2.7287	-0.1782	0.1782
7	*Ephestia cautella*	27	0.1210	-4.4146	-0.0534	0.0534
8	*Cadra cautella*	12	0.0950	-3.0164	-0.1557	0.1477
	Total(∑)	245	1.0000		-1.6909	1.6909

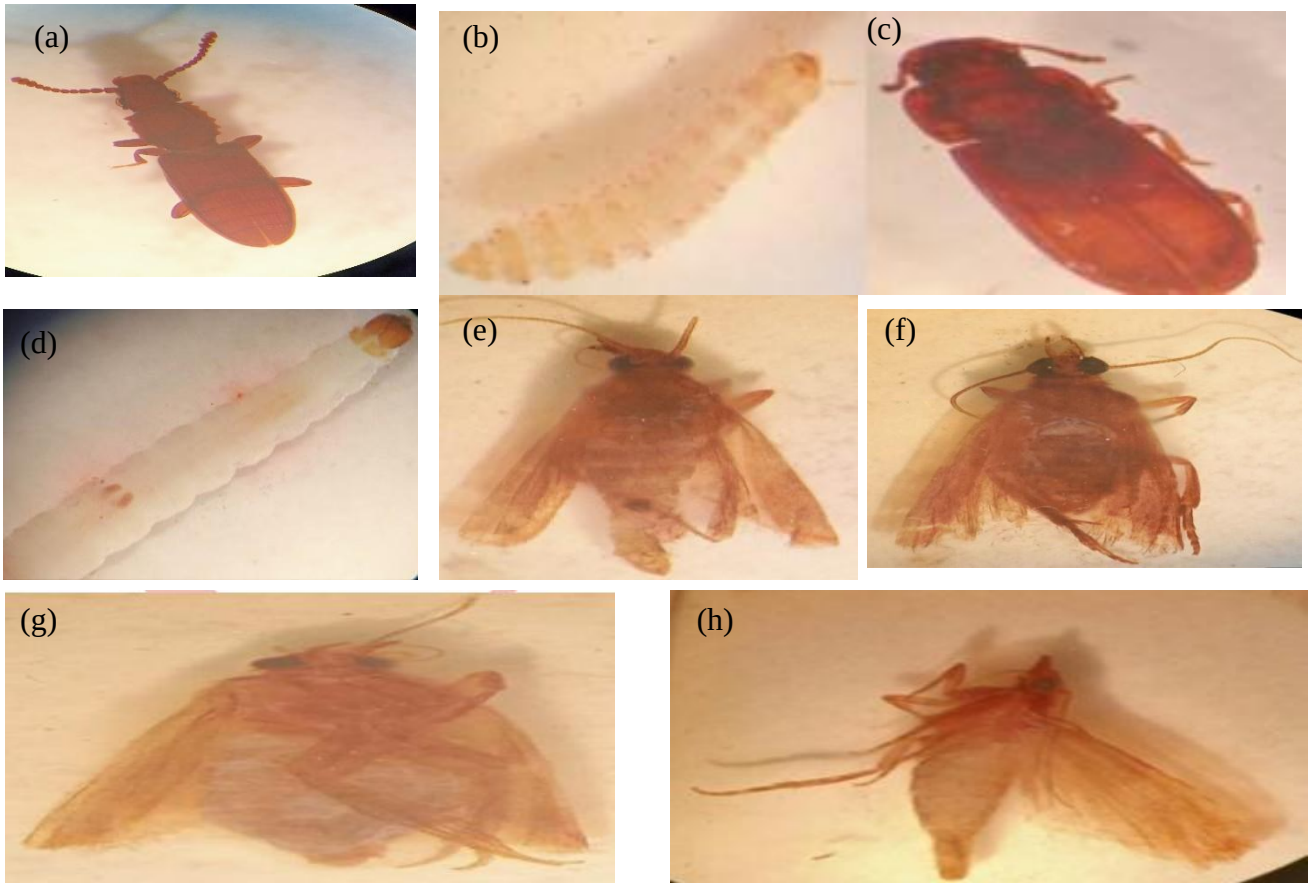

Fig. 1. Insect samples collected from randomly selected shops of Quetta. (a) *Oryzaephilus surinamensis*; (b) Larvae of *Oryzaephilus surinamensis*; (c) *Tribolium castaneam*; (d) lavae of *Tribolium castaneam;* (e) Larvae of *Plodia interpunctella;* (f) *Plodia inter punctella;* (g) *Cydia pomonella;* (h) *Ephestia figulilella*

PEST MANAGEMENT STRATEGIES

To effectively control pests in dry fruits that have been stored, a combination of chemical, biological and cultural control methods must be used. Based on observations the following strategies are proposed.

With 65% of shopkeepers reporting regular use, Malathion 57 EC was the most commonly applied chemical. Usually sprayed on storage surfaces like walls, racks and floors, Malathion demonstrated a

practical pest control effectiveness of roughly 60–70% based on vendor-reported results and observed infestation reductions, especially against crawling pests like *Sitophilus oryzae* and *Tribolium castaneum.*

According to vendor surveys and field observations, the most popular non-chemical techniques for controlling insect pests in stored dry fruits were dry roasting, roasting with salt, neem leaves, and bay leaves.

In order to lessen pest infestation and preserve product quality, a number of vendors also mentioned routinely cleaning storage areas, removing contaminated goods and employing sealed containers. These methods were favored due to their accessibility, affordability, and ease of use.

In order to avoid pest infestation and preserve product quality, a number of shopkeepers stated during the survey that they kept most of their dry fruits in cold storage facilities. They only kept small quantities in their stores that were meant to be sold right away.

None of the vendors reported using natural enemies, microbial agents, or other biological control agents for pest management, and no biological control techniques were seen during the survey. The results show that while traditional cultural practices are widely used dry-fruit vendors in Quetta are still not very aware of or utilize biological control techniques.

DISCUSSION

The present study recorded a total of seven insect pest species belonging to two orders, Coleoptera and Lepidoptera, and four families Silvanidae, Tenebrionidae, Pyralidae, and Tortricidae—from twenty randomly selected dry fruit retail shops in Quetta, Balochistan. Among these, the family Pyralidae contributed the highest number of species (four), followed by one species each from Tortricidae, Tenebrionidae, and Silvanidae. The identified species included *Oryzaephilus surinamensis*, *Tribolium castaneum*, *Plodia interpunctella*, *Ephestia figulilella*, *Ephestia cautella*, *Amyelois transitella*, and *Cydia pomonella*. Of these, *Oryzaephilus surinamensis* (sawtoothed grain beetle) emerged as the most dominant species, accounting for 92 individuals, followed by *Plodia interpunctella* (n = 53), while *Cydia pomonella* was the least abundant (n = 11). These findings are consistent with those of Mohsin (2025), who reported *O. surinamensis* as the most destructive insect pest infesting stored dates (7). Similarly, Chaudhry and Mahla (2001) documented ten insect species associated with stored dry fruits, further corroborating the species richness observed in the present study (8).

The prevalence of *O. surinamensis* as the predominant pest can be attributed to its high reproductive capacity, short developmental period, and ability to thrive on a wide range of dried commodities. Its occurrence across multiple dry fruit types in Quetta's local markets underscores the need for targeted monitoring and management strategies. The presence of *T. castaneum* and *P. interpunctella* aligns with earlier reports by Ali *et al.,* (2009), who identified red flour beetle and rice weevil as major pests of stored commodities (9). Furthermore, Johnson *et al.,* (2002) documented *A. transitella* as the most common pest of figs, a finding that supports its presence in the current study, albeit in lower numbers (10). The relatively low abundance of *C. pomonella* may be attributed to its specific host preferences and limited adaptability to the dry fruit storage environment compared to other polyphagous species.

Infestation rates varied considerably across the ten dry fruit types sampled. The overall prevalence of insect pests was recorded at 49.8%, with the highest infestation rates observed in dried apricots (56%) and dried dates (54%), while black currants exhibited the lowest infestation rate (40%). These variations are likely influenced by differences in moisture content, nutritional composition, and physical texture among the fruit types, which affect their susceptibility to pest colonization. The elevated infestation levels in dried apricots and dates may be due to their higher sugar content and softer texture, which facilitate oviposition and larval development. These results are in agreement with the findings of Bakhtawar *et al.,* (2013), who reported that approximately 44% of dry fruits in Southern Punjab were infested by *T. castaneum* and khapra beetle (*Trogoderma granarium*) (11). Moreover, Johnson *et al.,* (2001) observed that up to 85% of *A. transitella* individuals were collected from fig samples during their investigation, highlighting the commodity-specific pest preferences that were also evident in the present study (12).

The Shannon–Wiener diversity index revealed moderate species diversity among the collected pest fauna, with *O. surinamensis* being the overwhelmingly dominant species. This pattern is characteristic of storage ecosystems, where a limited number of adaptable and resilient species tend to flourish under stable but often unsanitary conditions. Similar observations were made in Kashmir, where diversity indices were employed to quantitatively assess species distribution across three districts, revealing seven families and ten species across three orders, with Hemiptera exhibiting particularly high abundance (13). The relatively low species diversity recorded in the present study may be attributed to the homogeneous storage environments and consistent commodity types across the sampled shops, which favor the proliferation of a few highly competitive species.

Seasonal analysis of pest activity demonstrated a clear peak during the summer months, with the highest infestation levels recorded in August (16.9%), followed by September (15.0%), July (12.8%), and June (10.1%). Pest activity gradually declined from October (9.8%) through the winter months, reaching its lowest point in January (1.5%). This pronounced seasonality is closely linked to the prevailing climatic conditions in Quetta, characterized by hot and dry summers that accelerate insect development, reproduction, and population growth. Conversely, lower temperatures during winter months slow down metabolic rates and extend developmental periods, thereby reducing infestation pressure. These findings closely correspond with those of Husain *et al.,* (2024), who also documented peak pest activity in August (24.7%) and minimal activity in November (14). The correlation between seasonal temperature fluctuations and pest population dynamics underscores the importance of implementing timely, seasonally adjusted management interventions.

The pest management practices adopted by local vendors were predominantly chemical in nature, primarily due to their rapid action, cost-effectiveness, and ease of application. According to field observations and vendor surveys, approximately 80–85% of dry fruit retailers in Quetta relied on chemical pesticides as their primary control strategy. The most commonly used compounds included Malathion 57 EC, Dichlorvos 76 EC (DDVP), and aluminum phosphate tablets. Notably, around 65% of store owners reported applying Malathion 57 EC to walls, racks, and floors of storage areas. These practices are consistent with the findings of Rajendran and Sriranjini (2008), who reported that 48% of stored product handlers employed chemical methods, primarily using phosphine tablets and phenyl formulations, while 76% of respondents utilized some form of pest control measures during storage (15). Despite their widespread use, the over-reliance on chemical insecticides raises concerns regarding food safety, human health risks, environmental contamination, and the potential development of insecticide resistance.

In contrast, cultural and physical control methods demonstrated considerable efficacy in reducing pest infestations. Practices such as regular cleaning, sun drying, use of airtight containers, freezing at −18°C, and application of natural repellents like neem leaves and bay leaves were adopted by a subset of vendors. Over a six- to eight-week period, vendors implementing these techniques—particularly in markets such as Kandahari Bazaar and Satellite Town—reported a 70–85% reduction in insect infestations, with noticeable declines in webbing, larval presence, and boreholes in dry fruits. These observations align with the findings of Singh et al. (2021), who documented the efficacy of neem leaf powder, black pepper, turmeric powder, and sweet flag rhizome powder in managing stored grain pests (16). Additionally, a localized survey conducted among 25 vendors in Liaquat Bazaar and Toghi Road indicated that natural repellents provided moderate but meaningful protection, especially when combined with good sanitation practices. Vendors employing FIFO (first-in, first-out) stock rotation and routine cleanliness experienced lower moth infestations and superior product quality compared to those relying solely on chemical treatments.

Freezing at −18°C for two to three days was adopted by approximately 60% of Quetta vendors, with an estimated efficacy of 60–75% in eliminating insect eggs and larvae, particularly those of *P. interpunctella* and *T. castaneum*. These results are comparable to those reported by Kaliq *et al.,* (2014), who observed that freezing at −20°C for 48–72 hours achieved 70–85% pest mortality and nearly complete eradication of storage pest larvae and eggs in dry fruit facilities in Gilgit and Hunza (17). The effectiveness

of freezing as a physical control measure underscores its value as a non-chemical alternative that can be readily integrated into IPM programs.

Sanitation and proper storage practices were consistently identified as critical factors in reducing infestation levels. Key measures that proved effective included the removal of damaged and fallen fruits, storage in airtight containers, regular inspection and cleaning of storage areas, maintenance of optimal temperature (10–15°C) and low humidity, and pre-storage freezing of dry fruits. These findings are in line with those of Bakhtawar *et al.,* (2013), who emphasized that improved sanitation, routine inspection, and proper grain storage substantially decreased insect infestation in Punjab, Pakistan (18). Collectively, the results of this study highlight the need for an integrated approach that combines chemical, physical, cultural, and biological tactics to achieve sustainable and effective pest management in stored dry fruits.

CONCLUSION

The study reveals that insect infestation is a significant and prevalent problem in dry fruits stored in Quetta markets, with an overall infestation rate of 49.8%. Infestation levels exceeded 54% in commodities such as dried dates, pistachios, and dried apricots, affecting more than half of the surveyed shops. Seasonal variation played a critical role, with peak infestation occurring during summer months (August and September), when elevated temperatures accelerated pest life cycles. The dominant species recorded were *Oryzaephilus surinamensis*, *Plodia interpunctella*, and *Ephestia cautella*, indicating substantial reproductive potential under prevailing storage conditions.

Pest management in Quetta remains heavily reliant on chemical insecticides, particularly Malathion, Dichlorvos, and aluminum phosphide, despite growing concerns over resistance, residues, and improper application. Biological control methods remain underutilized due to limited infrastructure and awareness. In contrast, cultural practices including improved storage hygiene, airtight containers, and natural repellents such as neem and bay leaves demonstrated 70–85% efficacy in reducing infestations within 6–8 weeks.

The findings underscore the urgent need for an integrated pest management (IPM) framework tailored to local conditions, combining chemical, biological, and cultural tactics. Additionally, awareness campaigns, regulatory monitoring of pesticide use and promotion of safer alternatives are essential to mitigate economic losses and ensure food safety in Quetta's dry fruit supply chain.

Recommendation:

To reduce insect infestation in stored dry fruits, proper storage techniques should be used, such as keeping moisture levels low and utilizing airtight containers. It is advised to conduct routine inspections and apply Integrated Pest Management (IPM) techniques in order to minimize post-harvest losses and reduce reliance on chemical pesticides. Considering Baluchistan's climate, more research should look into seasonal variations in pest infestation and assess environmentally friendly control strategies.

Conflict of interest:

The authors report no conflicts of interest

Author's contributions:

AN Conceptualization, data curation, writing and statistical analysis; NR Supervision and project administration.

Declaration of generative AI-Assisted Tools:

No AI-assisted tools were used by the authors.

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