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Physico-Chemical Evaluation of Different Commercial Samples of *Bunium persicum* (Shahizeera)

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KEYWORDS

Bunium persicum, food standards, volatile oil, extraneous matter, total ash

ABSTRACT:

Introduction: ***Bunium persicum*** Boiss. (Apiaceae), commonly known as Shahizeera or Kala Jeera, it is a valuable spice used for both culinary and medicinal purposes. Despite its ethnopharmacological relevance, the lack of proper quality assessment may result in adulteration, reduced efficacy, and safety concerns.

Methods: Standard food quality tests were applied to samples of ***Bunium persicum*** grown in soil of Iran, Jammu & Kashmir, and the same product from an authenticated shop (Gandhi Ashram), in Lucknow. All three were analysed for extraneous matter, moisture content, total ash, ash insoluble in dilute hydrochloric acid, volatile oil content, and insect-damaged matter, as per methods described in AOAC (Association of Official Analytical Chemists) manuals and ISO (International Organisation for Standardisation) guidelines.

Results: The values of extraneous matter in three different samples of ***B. persicum*** were calculated to be around 0.9%, 0.9%, and 0.7%, whereas the moisture content was found to be 8.7 %. The total ash and acid-insoluble ash were calculated to be around 8.8% and 1.3%, respectively. Volatile oil content in samples of *B. persicum* was estimated to be around 3.1 %, whereas insect damage was around 0.7 %.

Conclusions: The values of. extraneous matter ≤ 1.0, moisture ≤ 12.0, total ash ≤ 9.0, volatile oil ≥ 1.5, acid insoluble ash ≤ 2.0 and insect damage matter ≤ 1.0 match with the observed values in the three samples from different sources. The values obtained ensure the suitability of all the samples as per food safety standards and are free from any adulteration and safe for consumption.

1. Introduction

Spices have historically played a pivotal role in human nutrition, medicine, and trade. Among them, ***Bunium persicum*** Boiss. (Apiaceae), also called black caraway or kala zeera, is a traditional spice native to Central and South Asia, particularly Iran, Afghanistan, Pakistan, and the Himalayan region of India **[1].** It is distinguished by its strong aroma, bitter taste, and pharmacological significance in digestive, hepatoprotective, and antioxidant applications **[2].**

The seeds are rich in essential oils, mainly cuminaldehyde, γ-terpinene, p-cymene, and other terpenoids, which impart not only flavour but also have a variety of therapeutic effects. In traditional medicine, ***Bunium persicum*** has been used to treat flatulence, indigestion, and liver ailments **[3].** Recent studies have confirmed its antimicrobial, antioxidant, and anti-inflammatory activities, making it valuable in both food and pharmaceutical industries **[4].**

However, ***Bunium persicum*** is among the most expensive spices due to its limited cultivation and high demand. This often leads to adulteration with cheaper substitutes, such as cumin (Cuminum cyminum) or caraway (Carum carvi). Quality variations may also arise from differences in geographical origin, harvesting,

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storage, and handling **[5, 6].** Therefore, evaluating and standardising its food quality parameters from different regions is essential to ensure authenticity, safety, and compliance with international trade regulations.

The present work evaluates the food quality standards of ***Bunium persicum*** from Iran, Kashmir and Lucknow, using widely recognised tests, including extraneous matter, moisture content, total ash, insoluble ash, volatile oil content, and insect-damaged matter.

2. Materials & Methods

2.1. Procurement of samples

Seeds of ***B. persicum*** were purchased from three different sources of the region: sample 1 was from Tehran, Iran, sample 2 was from Kunzer, Kashmir, and sample 3 was from Gandhi Ashram, Lucknow. All these samples were washed thoroughly with water, dried in the shade and powdered in a mixer grinder.

2.2. Content of Extraneous Matter

Foreign materials such as stones, dust, plant residues, or other impurities were manually separated and weighed. According to ISO, extraneous matter should not exceed 1% by weight **[7].**

The following formula provides the mass fractions of organic extraneous matter (W_{OM}) and inorganic extraneous matter (W_{IM}), both stated as percentages.

$$\mathbf{W_{IM}} = \frac{WIM}{Ws} \times 100$$

$$\mathbf{W_{OM}} = \frac{WOM}{WS} \times 100$$

% extraneous matter (W_{EM}) = W_{IM} +W_{OM}

Where,

W_{IM} = mass, in g, of inorganic extraneous matter

W_{EM} = mass, in g, of organic extraneous matter

W_S = mass, in g, of the laboratory test sample or test portion, as appropriate

2.4. Moisture Content (Dean and Stark Method)

The moisture content of ***Bunium persicum*** seeds was determined by the Dean and Stark toluene distillation method. In this method, the sample was co-distilled with toluene, and the water was collected in a graduated receiver. Since toluene forms an azeotrope with water and distils at a temperature lower than the boiling point of water, this technique prevents the loss of volatile constituents that may occur in oven-drying methods **[8].** The same procedure was followed for all three samples, and the percentage of moisture was calculated based on the weight of the samples and the volume of water collected.

$$\textbf{Moisture \%} = \frac{Volume\ of\ water\ collected\ (mL)}{Weight\ of\ a\ sample\ (g)} \times 100$$

Where,

V = Volume of water collected in mL and

M = Mass of the test portion in g

This method is particularly useful for spices and essential oil-containing seeds such as ***Bunium persicum***, where direct heating may lead to loss of volatile oils and inaccurate estimation

2.4. Total ash content (on dry basis)

To determine the overall mineral content, the samples were burned in a muffle furnace at 550 °C for three to four hours, destroying the biological matter until the mass remains constant. Calculate the values with the remaining weight of the samples. A value of not more than 9% is considered acceptable **[9].**

$$\textbf{Total ash, \% by mass} = \frac{W2-W0}{W1-W0} \times 100$$

Where,

W_0 =mass of empty dish, in g

W_1 =mass of dish and test portion, in g

W_2 =mass of dish and total ash, in g

2.5. Ash insoluble ash content in dilute HCl (on dry basis)

The ash of all three samples was treated individually with dilute HCl to measure the proportion of acid-insoluble materials. Excess values may indicate contamination from soil, with an acceptable limit of 1.5% **[10].**

$$\textbf{Acid insoluble ash (\% by mass)} = \frac{(W2-W0)}{(W1-W0)} \times 100$$

Where,

W_0 =mass of empty dish in g

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W_1 = mass of dish and test portion in g

W_2 = mass of dish and acid-insoluble ash in g

2.6. Volatile oil content (on dry basis)

Hydro-distillation was performed with all the samples for 3 hours using a Clevenger-type apparatus. The essential oil yield was measured individually and expressed as a percentage by weight (v/w) **[11].**

$$\textbf{Volatile oil \% (v/w)} = \frac{V}{W} \times 100$$

Where,

V = volume of oil collected in the trap (mL)

W = mass of the test portion (g)

2.7. Insect-damaged matter

Insect-damaged matter (IDM) was determined by manually inspecting all three representative samples of 10 g of ***Bunium persicum*** seeds individually. Seeds showing insect infestation, holes, tunnelling, excreta, or dead/live insects were separated and weighed **[12].** IDM (%) was calculated using the formula:

$$\textbf{Insect-Damaged Matter (\%)} = \frac{(Weight\ of\ insect\ damaged\ seeds)}{Total\ sample\ weight} \times 100$$

3. Results

3.1. Extraneous matter content

Table 1 presents the quantities of organic, inorganic and total extraneous matter in various samples of 10 g of seed powder with their calculated percentage values. The removal of dust, stones, and non-edible materials ensures purity. Higher levels may indicate poor harvesting or post-harvest handling. 10.0001 g from different samples of ***B. persicum*** was taken for the analysis. The percent value calculated for the same was **0.9%, 0.9% & 0.7%** which is less than the standard value.

Table 1: Analysis of total organic, inorganic and extraneous matter in three samples of *B. persicum* seeds

Content (per 100 g)	Sample 1	Sample 2	Sample 3
Organic Matter	0.792±0.005	0.755±0.002	0.619±0.003
Inorganic Matter	0.112±0.002	0.147±0.001	0.120±0.002
Total Extraneous %	**0.9**	**0.9**	**0.7**

The results are the average of three independent experiments.

3.2. Moisture content:

High moisture favours fungal and bacterial growth, leading to aflatoxin contamination, which poses significant health risks. A limit of 10% is essential for maintaining stability, and the calculated moisture values of the 25 g of ***B. persicum*** samples from Iran, Kashmir & Lucknow were **8.7%, 7.9% and 8.3%.**

3.3. Total ash and acid-insoluble ash content:

These parameters reflect mineral composition and inorganic contamination. While normal mineral content is expected, excess ash may result from adulteration with soil or mineral dust. The calculated values of total ash on a dry basis of all the samples were **8.8%, 8.7% & 9.0%.** Acid-insoluble ash specifically points to silica or sand contamination. The values of the acid-insoluble ash of 2.0 g of the three samples were approximately **1.3%, 1.7%** and **1.9%.**

3.4. Volatile oil content:

The therapeutic and culinary value of ***B. persicum*** largely depends on its essential oil yield. A lower oil content indicates inferior quality or adulteration with other spices. Variations in oil yield may also arise due to environmental conditions and storage practices. The total volume of essential oil from 25.0 g of the samples was 0.8 ml, 0.6 ml and 0.5 ml, constituting **3.1%, 1.9 % & 2.3%.**

3.5. Insect-damaged matter:

Insect infestation reduces nutritional value, increases microbial load, and compromises food safety. The calculated values of the samples individually were **0.7%, 0.5% & 0.9%** ensuring low levels (<1%) are acceptable for consumer acceptability and trade certification.

Table 2: Analysis of contents in samples of seeds of *B. persicum* from different sources

Content (per 100 g dry powder)	Sample 1 (Iran)	Content Sample 2 (Kashmir)	Sample 3 (Lucknow)	Specified limits %
Extraneous matter (g)	**0.9**	**0.9**	**0.7**	≤ 1.0
Moisture (%)	**8.7**	**7.9**	**8.3**	≤ 12.0
Total ash (g)	**8.8**	**8.7**	**9.0**	≤ 9.0
Ash insoluble in dilute acid	**1.3**	**1.7**	**1.9**	≤ 2.0
Volatile oil v/w (g)	**3.1**	**1.9**	**2.3**	≥ 1.5
Insect-damage matter (g)	**0.7**	**0.5**	**0.9**	≤ 1.0

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Collectively, these tests form a reliable basis for standardisation, ensuring compliance with ISO and AOAC standards. Similar approaches are used for other spices, such as cumin and fennel; however, given the higher economic and medicinal value of ***B. persicum***, stringent regulation is very important.

4. Conclusion

The assessment of food standards for ***Bunium persicum*** seeds from three different geographical regions highlights the importance of systematic evaluation to ensure their authenticity, purity, and safety. Parameters such as extraneous matter, moisture, ash values, volatile oil content, and insect damage provide a comprehensive framework for quality control. Since there are no differences in the computed values, all three samples are acceptable in accordance with the standard values of ISO and AOAC guidelines. Harmonisation of these standards across international regulatory bodies will not only safeguard consumer health but also promote fair trade of this economically valuable spice. Future studies may focus on molecular authentication and the application of advanced analytical techniques (GC-MS, HPTLC) to complement traditional food quality tests.

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