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Research Article

Efficacy of Ksharjala a vegetable wash on pesticide residue in Cauliflower: An experimental study

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Abstract

Background: Cauliflower is a common vegetable in Indian households; it is highly nutritious which is often sprayed with pesticides. The majority of the residue is still on the vegetable even after washing it with tap water. It poses a risk to consumer safety and the security of the food industry. Thus, A study was conducted to find out an easy method to lower the pesticidal residue which was detected in large amounts on cauliflower. Methods: A pilot study was done to identify the pesticide residue on cauliflower sample which were selected at random. Pesticide residue was analysed using gas liquid chromatography and mass spectrometry, and sample extraction was carried out using the QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe) method. The sample were divided into two groups; control group and experimental group. The experimental group samples were washed with *ksharjala*. *Ksharajala* was prepared by mixing 20 grams of sodium bicarbonate into 1000 ml of water (2% alkaline solution). Result- The mean pesticide residue of the experimental groups i.e. *ksharajala* (17.29 ppm) differed significantly from that of the control group (107.44ppm,). *Ksharjala dhavana* decrease chlorpyrifos residue. Positive alterations have been observed in the colour, taste, and smell of cauliflower. Conclusion: Study has shown that *ksharjala* effectively reduces the amount of pesticide residue on cauliflower.

Keywords: Cauliflower, Chlorpyrifos, Vegetable wash, *Ksharjala*, Sodium bicarbonate, *Dhavana sanskar.*

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Introduction

Ahara supports the life by providing strength, complexion, nourishment and maintenance of the body in the whole lifespan. It is undeniable that consuming a balanced diet encourages physical development. Consumption and proper digestion of food that is rich in nutrients and adequate is one of the essentials for the body's growth.(1,2,3) Vegetables are the main component of Indian cuisine. They are included under “protective foods” because they are rich in vitamins and minerals. Vegetables contribute bulk of diet & are low in calories, proteins and fats, contributing major part of dietary fibers.(4) Among other veggies, cauliflower is a popular cruciferous vegetable which is frequently used in Indian households as it is very nutritious vegetable & also can be roasted, boiled, fried, steamed or eaten raw (5) Hence, for better yield and quality of cauliflower, pesticide is repeatedly applied during the entire period of growth, sometimes at the fruiting stage to keep way the disease-causing organisms & to preserve the freshness of harvested cauliflower. Concern about food safety and human health have been greatly increased by the growing use of pesticides in agriculture. Owing to the widespread use of pesticides, there might be residues left on the cauliflower's surface, which could pose a risk to customers' health.(6,7) Today contamination of vegetables by pesticides has become a burning problem and resulting into food pollution.(8) As per study conducted by Delhi based NGO consumer, the amount of pesticide used in edible is as much as 750 times the European standards. This leads to human health hazards, ranging from short-term impacts to chronic impacts. (9) The need for practical solutions to reduce pesticide residues on food continues to rise along with understanding of these hazards. So before going to cook vegetable, one should think about *karana sanskara*. *Karan* is one of the eight factors determining the wholesomeness of food known as "*Ashtavidha aharavidhivisheshayatan*". The mode of preparation or processing, changes the natural properties of the substances to a great extent. *Dhavana* (wash) is a type of *sanskar* (process) responsible for the wholesome effect of food. (10,11) It is nothing but proper cleaning or washing vegetables in order to prevent its unwholesome effect on health. Some pesticides are not readily soluble in water, so, washing vegetables with tap water is not that much effective in reducing the pesticide residue on it. (12) In ayurveda classics it is mentioned that “all “*kshara”* are “*malahara*”; as it removes *mala* or any contamination. (13) Pesticide residues are nothing but contaminants resulting into hazardous health effects due to food contamination. (14) The *sajjikshara* mentioned in Ayurveda classics can be correlated with sodium bicarbonate. Hence a study was conducted to study the effect of *ksharjala* an alkali wash on pesticidal residues and

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ensuring safe consumption of pesticide free vegetable in future. This article presents the findings of an experimental study aimed at evaluating the efficacy of *ksharjala* in reducing pesticide residues on cauliflower.

Materials and Methods

Place of study: Pesticide Residue Testing (PRT) Laboratory, Nagpur & Bhausaheb Mulak Ayurved Mahavidyalaya, Nagpur (Maharashtra).

Study design: An experimental study

Materials:

1. Cauliflower (*Brassica oleracea var. botrytis*), 2. *Ksharajala* (alkali wash- aqueous solution of sodium bicarbonate-NaHCO3) which is prepared by mixing 20 gms of NaHCO3 (Sodium bicarbonate) in 1000 ml of distilled water. **Preparation of *ksharjala***- 20 gm of sodium bicarbonate were added to 1000ml of distilled water (2%).

Instrument: The analysis of pesticide residues in cauliflower was carried out using a Gas Chromatograph coupled with a Mass Spectrometer (GC-MS), equipped with an electron impact (EI)

Instrument Specifications:

- **Instrument Model:** GC-MS (Agilent 7890A GC system coupled with 5975C MSD)
- **Column:** Capillary column (HP-5MS, 30 m × 0.25 mm i.d., 0.25 µm film thickness)
- **Carrier Gas:** Helium (99.999% purity) at a constant flow rate of 1.0 mL/min
- **Injector Temperature:** 250°C
- **Injection Mode:** Splitless
- **Oven Temperature Program: Initial temperature:** 70°C (hold for 2 min) **Ramp:** 10°C/min to 280°C (hold for 10 min)
- **Ionization Mode:** Electron Impact (EI) at 70 eV
- **Mass Range:** m/z 50–550
- **Detector:** Quadrupole Mass Analyzer

Sampling method: Samples were randomly selected from market as per the selection criteria.

Sample size: 5 kg of fresh cauliflower

Selection criteria: Fresh cauliflower, sample of Rabi season was included.

Exclusion criteria: Sample of rainy and summer season, sample infested by insect-pest and any disease excluded, stale sample was avoided.

Plan of study: 5kg cauliflower was randomly collected from the market.

Cauliflower was tested at Pesticide Residue Testing (PRT) center, Nagpur for presence of pesticide residue by using Gas Liquid Chromatography with Mass Spectrometry (GC-MS) method. It is a technique for separation of mixtures into components by a process which depends on the redistribution of the components between a stationary phase and gaseous mobile phase. (15) It was found that chlorpyrifos an organophosphorus pesticide was present in high concentration. The sample was divided into two groups i.e. Group A- control group and Group B - Experimental group. Each group was again divided into 5 subgroups. Sample from Group A were unwashed & analyzed for pesticide residues. Group B samples were washed with *ksharjala* & analyzed for residues. Both the group samples were compared for the concentration of pesticide residue.

Method

Fig. 1-Extraction of sample by QuEChERS method

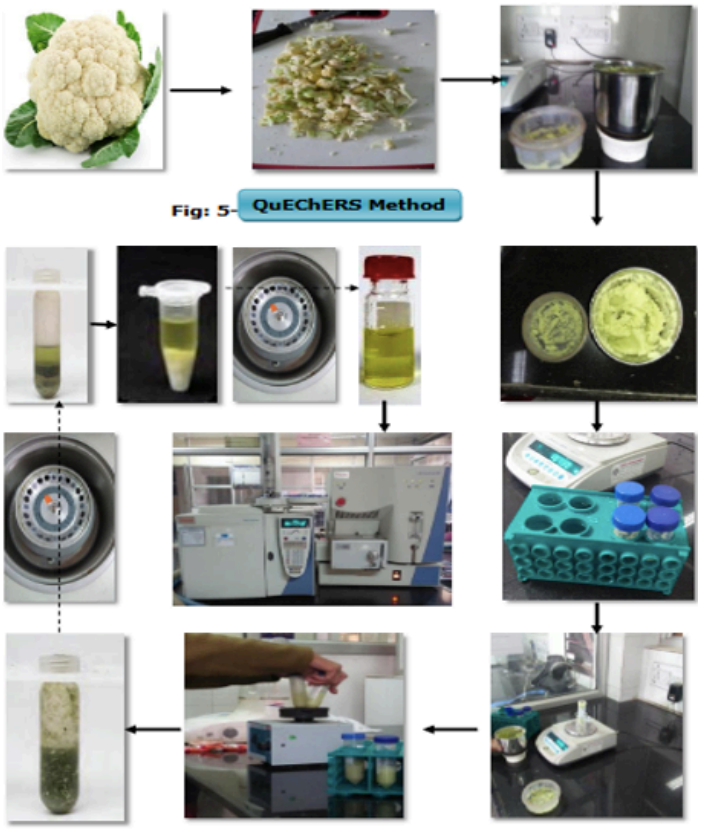
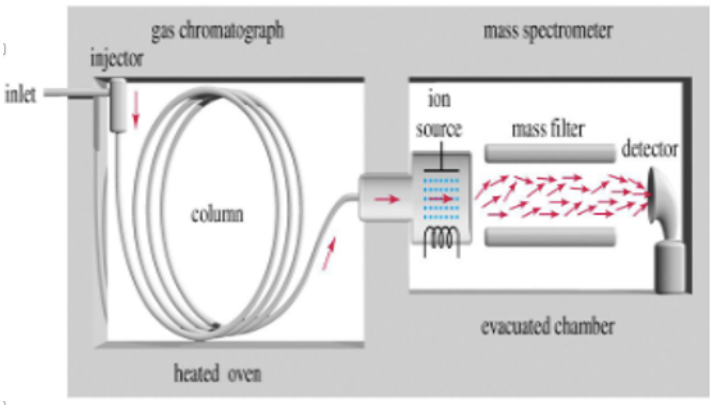


Fig.2- Diagrammatic presentation of GC-MS



The pesticide analysis was carried out into two stages: Extraction of pesticide and analysis of extract.

Extraction of pesticide

Cauliflower samples were subjected to extraction procedures to isolate pesticide residues. A solvent extraction method, such as QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe), was employed for efficient extraction of pesticides from the cauliflower surface.(16) Procedure- 250 gm of cauliflower sample cut in to pieces and blended into homogenized paste with the help of grinder. Take 10 gm of homogenized sample in 50 ml

centrifuge tube. It was spike for recovery and Quality check. 10 ml ethyl acetate and 10 gm of sodium sulphate was Added. Vertex for 2 min. Centrifuge the extract for 5 min at 3000 rpm at 5°C. we got supernatant liquid. Clean up: Required for Quantification of pesticides in GLC (GC- MS). 2ml liquid supernatant is taken in Eppen drop and added 25mg PSA (Primary Secondary Amine). Mixed it thoroughly by vertexing it for 1 min. Centrifuged at 10000 rpm at 5°C for 5 min. Extract is then filtered through Nylon 6, 6 membrane filter paper (0.22µm) and filled in 2 ml vials.

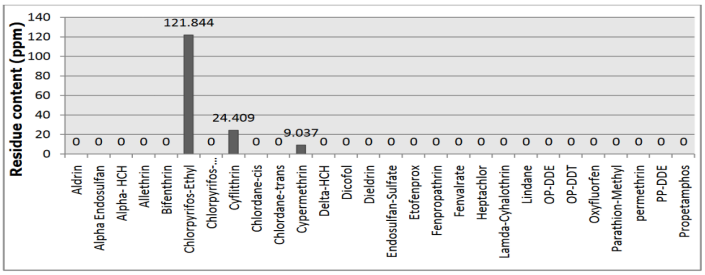
Analysis of extract

Extracts were injected on GC-MS instrument & analyzed for pesticide residue. This procedure was followed for all 10 subgroups collected from control group & experimental group to obtain respective readings of pesticide residue. The reading of experimental group was compared with the readings of the control group to assess the effectiveness of *ksharajala* in removing pesticide residue on cauliflower. (17,18)

Results

When cauliflower was tested for presence of pesticide residue by using GC-MS method, it was found that three pesticide residues were present in sample i.e. Chlorpyrifos-Ethyl, Cyfluthrin and Cypermethrin with concentration 121.844ppm, 24.409ppm and 9.037ppm respectively. (Graph.1) As Chlorpyrifos- Ethyl was present in high concentration and so, it was considered for further study.

Graph 1: Showing concentration of different pesticide residue present on cauliflower in pilot study



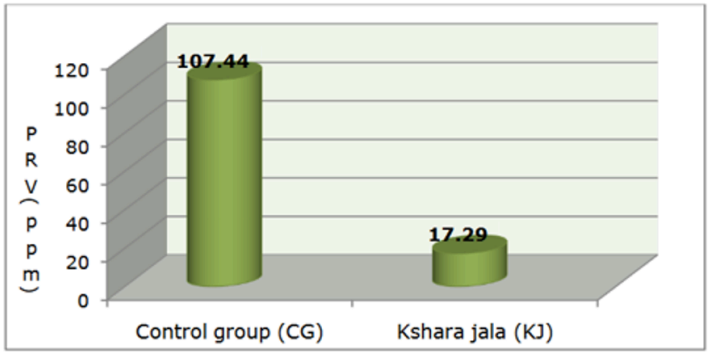
Samples of control group & experimental groups were analyzed for pesticide residue and the following observations were found. The mean pesticidal residue level of chlorpyrifos in cauliflower of Group A & Group B were 107.44ppm and 17.29 ppm respectively. (Table .2)

The mean of pesticidal residue level in control group was found to be 107.44ppm & that of Group-B was 17.29 ppm. The expected 't' value at $P < 0.05$ is 2.31 and the observed value was 9.61. Thus, it was experimentally proved that there is statistically significant reduction of chlorpyrifos pesticide residue on cauliflower by *ksharjala dhavana*. (Table 2).

Table 2: Pesticide concentration in control and experimental group samples

Sr. No.	Control Group- Group A CG- Unwashed samples (ppm)	Experimental Group-Group B KJ-Washed with ksharjala (ppm)
1	126.87	20.26
2	114.73	16.17
3	108.66	17.40
4	71.22	12.94
5	115.74	19.70
Mean	107.44	17.29

Graph 2: Mean of chlorpyrifos pesticide concentration in control group & treatment group



Statistical analysis

Statistical analysis of mean of pesticide residue of both the groups was made and significance was experienced by using 'unpaired t test'. There was significant difference between mean pesticide residue of control group and experimental group. It was found that chlorpyrifos level was reduced to a great extent in Group B. The difference is considered to be statistically significant. It was also observed that there were also positive changes in color, odor and taste of cauliflower in Group B.

Discussion

Washing vegetables with water before cooking is a common practice. However, because of uneven surface of cauliflower, washing doesn't successfully remove pesticide residue from it. Washing methods like washing in tap water, soaking in water, boiling, blanching, using vinegar solution, salt solution etc., are the methods are generally used for vegetable washing. *Dhavana* is one of the *sanskar* explained in Ayurveda under the head *Ashtavidh Aharavidhi Visheshayatan* which are the factors responsible for wholesome effect of food.

A study carried out to evaluate the pesticide contamination in cauliflower and related health risk assessment in Gurugram. According to that study, Organophosphates (OPs), synthetic pyrethroids and organochlorines (OCs) pesticide residues were present in 50 %, 41.67 %, and 16.67 % of the total samples collected from Gurugram, respectively. Among the organo-phosphate, chlorpyrifos was detected in the majority of the collected samples. In the study, washing the samples with running water led to the highest removal efficiency among all methods, whereas washing with detergent led to the lowest removal efficiency. Chlorpyrifos is a broad spectrum organophosphorus (OP) insecticide, widely used in agriculture and possesses low water solubility. (19) As per the study conducted by Medical Toxicology Center in Mashhad University of Medical Sciences in Iran, administration of high doses of sodium bicarbonate appears to be beneficial in treatment of patients with acute OP poisoning (20). In ayurvedic classics, *Kshara* are considered as *Malahar* as it helps in removing contamination. *Sajjikshar is* easily available and used in household practices; so that it was selected for *dhavana.* The maximum solubility of sodium bicarbonate in water is 8 gm/ 100ml at room temperature. (21) So that, *kshrajala* was prepared by considering 1/4th of *sarjjkshar* amount to avoid the saturation level. It is alkaline in nature and break down the pesticide residues into small molecules that are neutral and harmless. It generates valuable wash and also has antibacterial properties which removes food contaminant. In current study, cauliflower in Group A had a greater concentration of

chlorpyrifos-ethyl residues. The amount of pesticide residue found on group B cauliflower was significantly low which shows that *ksharjala* is an effective vegetable wash in removing pesticide residue on cauliflower. It was observed that the cauliflower's colour, flavour, and aroma had changed after washing with *ksharajala*. Based on the observed results, we can suggest *ksharajala dhavana* for vegetable and fruits for its safe consumption. Even though the level of chlorpyrifos is reduced to great extent after *dhavana* with *ksharjala*, the cauliflower was not still safe for ingestion as the amount of residue is still more than the maximum residue limit which means the amount of pesticide residue that is allowed in food products. For chlorpyrifos it is 0.05 ppm and the observed avg. value was 17.29 ppm which was too higher than that of the chlorpyrifos MRL. The cauliflower was simply washed without soaking in this study. Still, it was effective in reducing pesticide residue on cauliflower to a great extent. So, it is further suggested that the cauliflowers be soaked for 5-15 mins prior washing. This may yield better results & bring the chlorpyrifos concentration within safety levels.

Limitation of the study

Despite the methodical approach taken in this work. However, there are more opportunities for the results to be simplified when the financial and temporal limitations of the current study are taken into account. Increasing the sample size can help similar kinds of studies attain accuracy in their results. For improved results, repeat the same study with different vegetable soaking times, such as 10 and 15 minutes.

Conclusion

Compared to the typical home practice of washing tap water, washing with *ksharajala* showed greater effectiveness in removing residues. Because of this, we can advise *Ksharajala Dhavana* for the safe ingestion of fruits and vegetables.

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