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Correlation between proximate chemical composition and insect pests of loofah, *Luffa cylindrica* Mill., (Cucurbitales: Cucurbitaceae) cultivars in Peshawar

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Abstract
An experiment on the "Correlation between proximate chemical composition and insect pests of Loofah, *Luffa cylindrica* Mill., (Cucurbitales: Cucurbitaceae) cultivars in Peshawar" was carried out at the New Developmental Farm (NDF) of The University of Agriculture, Peshawar in 2014. Four loofah cultivars, i.e. Peshawar local, Chikni (India local), Agro (India hybrid) and Malik were sown separately in May, 2014 and replicated each three times. Population dynamics of insect pests was determined on each loofah cultivar at weekly basis. Proximate chemical composition of loofah leaves and fruits was determined of each loofah cultivar. Proximate chemical composition of loofah leaves and fruits yielded variable results for the four cultivars. Moisture, protein and vitamins were higher in leaves and fruits of Malik; ash and mg in Agro; Fe, Zn and Ca in Peshawar local. Fiber content was higher in leaves of Malik, while in fruits of Agro. Mg was higher in leaves of Peshawar local, while in fruits of Agro. These results may be utilized in developing a sustainable pest management strategy of insect pests of loofah in the agro-ecological system of Peshawar.

Keywords: Correlation, Insect pests, *L. cylindrica*, proximate chemical composition.

1. Introduction
Luffa cylindrica Mill., (Cucurbitales: Cucurbitaceae), otherwise known as Sponge gourd is a fibrous plant with fruits containing black seeds. Luffa plant is a curcurbit with other members including snake gourd, pumpkins and cucumbers. It grows as a flowering annual vine with pollinated flowers developing into cylindrical green fruits filled with seeds in a system of many intertwined cellulose fibres. The fruit is edible especially when young and it contains group of compounds such as phenolics, lavonoids, oleanolic acid, ascorbic acid, a-tocopherol, carotenoids, chlorophylls, triterpenoids and ribosome-inactivating proteins, which makes it highly effective when used for medicinal purpose. *L. cylindrica* contains chemical components that have effects on hypersensitivity reactions, serve as immune-stimulant, anti-inflammatory agent and function in glycosidase activity, inhibit protein synthesis with structural-function relationship of type I RIPs suggesting potentials for antitumour and antiviral activities, and also induce uterine contraction to hasten child birth (Oxytocics) [1].
Additionally, the luffin which was reported to be a ribosome- inactivating protein isolated from *Luffa* seed, has been shown to be effective against growth of parasites, protozoa, insects, fungi and HIV [2]. In a study dealing with the anti-inflammatory activity on macrophage cell, Bor and co-worker compared 25 vegetables and found that fresh Daylily was the most efficient in inhibiting LPS-induced NO generation, followed by *Luffa* [3]. The presence of functional components like polyphenols in *Luffa* may be responsible for this effect [4].
The sponge gourd and ridged gourd belonging to family Cucurbits are common vegetables throughout Pakistan. There is difference in the nutritive value of these two species. This crop is an annual of climbing or trailing habit and grown for its fruit, when tender is considered a good vegetable. The vegetables constitute an important item of human diets, according to a dietician, is 284g per head, i.e. about 20 per cent of the daily requirement of the total food of an adult [5].
Insect pests cause heavy damages to loofah crop each year in Pakistan. Fruit fly, red pumpkin beetle and epilachna beetle cause damage to most of cucurbits. In addition, insects like gall

fly; aphids, leaf hopper, ants, worms, underground semi loopers, leaf miners, fruit borers and mites affect specific cucurbits. Intensity of infestation varies from place to place [6].

B. cucurbitae is a major pest of majority of cucurbits especially that of bitter gourd, snake gourd, pointed gourd, muskmelon, oriental pickling melon, watermelon, tinda and pumpkin. Adult fly has reddish brown body with transparent and shiny wings, bearing yellow-brown streaks. It lays eggs singly or in clusters of 4-12 in flower or developing fruits or ripening fruits with the help of sharp ovipositor of females. Eggs hatch in 2-9 days and maggots feed on internal contents of fruits causing rotting. Pupation is in ground at a depth of 1.5-15.0 cm. Infestation is more during rainy season [7].

Intercropping trial in coconut (*Cocos nucifera* L.), was carried out for generating more income/yield. The Tori varieties planted ridge gourd (L*uffa acutangull*a Roxb.) and sponge gourd (*Luffa cylindrica* L.) under the trail staked and unstaked Tori were grown satisfactory under coconut plot. The results showed that the staked method compared to unstaked had 30-35% increase in yield and also insect pest protection [8].

Sponge gourd was shown to contain 20.74 mg/g of total phenolics, 17.94 mg/g of flavonoids, 0.5 mg/g of total anthocyanins and 1.2 mg/g of ascorbic acid [9]. While in Loofah seed, both oleanolic acid and echinocystic acid were the major triterpene acids present [10].

Red pumpkin beetle, *Aulacophora foveicollis* (Lucas), appeared on the host leaf from 7:00 am to 6:00 pm. In the early part of the day, insect first appeared at 7:00 am. Its population increased gradually with the progress of the day showing maximum population at around 9:00 am. After 9:00 am, its incidence started to decrease having the lowest population at 2:00 pm. In the later part of the day, population of *A. foveicollis* started to increase after 2:00 pm and continued up to 6:00 pm, when maximum incidence was recorded. Such trend of diurnal incidence of *A. foveicollis* was observed on three hosts (bottle gourd *(Lagenaria siceraria L.),* cucumber *(Cucumis sativus L.),* and muskmelon *(Cucurbita melo* L.), having different levels of susceptibility. Findings of the observation clearly showed that populations of the *A. foveicollis* were low during middle of the day when temperature is maximum. The temperature may be the principal factor for influencing diurnal distribution of *A. foveicollis* on cucurbits. [11].

Resistant varieties are less damage by the insect pests. It adversely affects growth and development of the pests. Varieties of cucurbits that have lower feeding concentrations of feeding stimulants (cucurbitacins) are less preferred [12].

Keeping in view the importance of loofah as vegetable crop, and the damage caused to it by various insect pests, the present study aimed to determine correlation between proximate chemical composition and insect pests of four loofah cultivars.

2. Materials and Methods

2.1 Experimental layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each replication consisted of four treatments. Each loofah cultivar, i.e. Peshawar local, Chikni (India local), Agro (India hybrid) and Malik was sown separately in each treatment. The loofah was sown in lines on ridges in May, 2014. A buffer zone of half meter was kept between the treatments for isolation. Size of the whole experimental field was 25 m x 14 m and size of each treatment was 5x4 m. Plant to plant and row to row distance was kept 6 cm and 65 cm, respectively. Standard agronomic practices were applied in the field throughout the loofah growing season. The field was left open for natural infestation of insect pests. Data was recorded on loofah leaves, stem and fruits from germination till maturity of the crops at weekly intervals.

2.2 Collection and recording of insect pests

The loofah plants were observed for aphids, thrips and fruit fly, etc. infestation every week after transplantation. For aphids, thrips and fruit fly the data was recorded on three randomly selected leaves (top, middle and bottom), flowers and fruits of each of the 10 selected plants in each of three rows per treatment, respectively. The two border rows were excluded from data recording. The insect pests were collected through an aspirator and were placed in glass vials. The collected insects were deposited at the Insect Museum of the Department of Entomology and the results reported [13].

2.3 Proximate chemical composition of loofah cultivars leaves and fruits:

Proximate chemical composition of loofah leaves and fruits was determined. Standard methods [14] for finding % moisture content, % ash, % crude protein, % crude fiber, and Fe, Zn, Ca and Mg (mg/100mg) of loofah leaves and fruits were used.

2.3 Statistical analysis

The data recorded for each parameter was analyzed statistically by using Statistix 8.1 Software and means were separated by using Fisher Protected Least Significance Difference Test (FPLSD) at 5% level of significance [15].

3. Results and Discussion

3.1 Proximate chemical composition of loofah cultivars leaves and fruits

The results in table 1 show that ash (12.2%) and protein (15.47%) content were significantly higher in Chikni than the other varieties. Fiber (16.98%), Fe (0.60 mg/100 mg), Zn (0.47 mg/100 mg) were significantly higher in Peshawar local than the other varieties. Moisture, vitamins and Mg were non-significantly different among the three varieties.

Table 1: Proximate chemical composition contents in leaves of four loofah cultivars in 2014.

Variety	Proximate chemical composition content								
	Moist-ure (%)	Ash (%)	Prot-ein (%)	Vita-mins (%)	Fiber (%)	Fe (mg/100 mg)	Zn (mg/100 mg)	Ca (mg/100 mg)	Mg (mg/100 mg)
Peshawar local	81.35a	5.48c	14.24a	0.00a	16.98a	0.60a	0.47a	9.55a	0.89a
Chikni	83.62a	12.28a	15.47a	0.01a	11.69b	0.42b	0.15c	4.28c	0.83a
Agro	81.74a	9.23b	14.50a	0.01a	11.21b	0.24c	0.28b	8.82b	0.96a
Malik	83.41a	9.5b	14.84a	0.01a	9.34c	0.77a	0.30b	9.80a	1.00a

Means in columns followed by different letters are significantly different at FPLSD test at 5% level of significance.

The results of proximate chemical composition of loofah fruits revealed that moisture, ash, vitamins and Mg contents were non-significantly different among the loofah varieties, where it was comparatively higher in Chikni than the other varieties (Table 2). Protein (16.64%) was higher in Chikni, while fiber (17.42 mg/100 gm), Fe (0.44 mg/100 mg), Zn (0.48 mg/100 mg) in Peshawar local than the other varieties. Ca (3.62 mg/100 mg) was higher in Malik and Mg (0.96 mg/100 mg) in Agro than the other varieties.

Table 2: Proximate chemical composition contents in fruits of four loofah cultivars in 2014.

Variety	Proximate chemical composition content								
	Moist-ure (%)	Ash (%)	Pro-tein (%)	Vita-min (%)	Fiber (mg/ 100 mg)	Fe (mg/ 100 mg)	Zn (mg/ 100 mg)	Ca (mg/ 100 mg)	Mg (mg/ 100 mg)
Peshawar local	91.53a	5.83a	14.37b	0.00a	17.42a	0.44a	0.48a	2.57b	0.95a
Chikni	92.57a	6.60a	16.64a	0.01a	16.09a	0.12b	0.28b	2.62b	0.94a
Agro	92.53a	6.50a	14.91b	0.01a	13.95b	0.40a	0.44a	2.30b	0.96a
Malik	92.27a	6.16a	16.04a	0.01a	11.51c	0.38a	0.38a	3.62a	0.94a

Means in columns followed by different letters are significantly different at FPLSD test at 5% level of significance.

3.2 Correlation between proximate chemical composition of loofah leaves and insect pests

The insect pests responded differently to the chemical contents of the leaves of four loofah varieties (Table 3). On Peshawar Local, the thrips and fruit fly were negatively correlated with the ash, protein, fiber and Ca, while the aphids to the Fe, Zn, Ca and Mg. On Chikni: fruit fly was negatively correlated with the fiber and Mg, while aphids to the moisture, ash, Proteins, vitamins and fiber. On Agro: the thrips and fruit fly were negatively correlated to the moisture, ash, Fe, Zn, while the aphids to protein, vitamins, fiber, Ca and Mg. On Malik: the thrips and fruit fly were negatively correlated to the ash, protein, Fe and Zn, while the aphids to the fiber and Mg.

Table 3: Correlation among proximate chemical composition of loofah leaves and insect pests of four loofah cultivars during 2014.

Cultivar	Pest	Correlation of proximate chemical composition of loofah leaves and pests								
		Moisture	Ash	Protein	Vitamin	Fiber	Fe	Zn	Ca	Mg
Pesh Local	Thrips	1.41*0.83	1.41*-0.95	1.41*-0.89	1.41* 0.70	1.41*-0.99	1.41*0.708	1.41*0.22	1.41*0.63	1.41*0.72
	F. fly	0.21*0.56	0.21*-0.40	0.21*-0.24	0.21*0.99	0.21*-0.59	0.21*0.99	0.21*0.88	0.21*-0.18	0.21*0.99
	Aphids	0.83*0.82	0.83*0.96	0.83*0.90	0.83*-0.78	0.83*0.99	0.83*-0.68	0.83*-0.19	0.83*-0.65	0.83*-0.70
Chikni	Thrips	1.30*0.70	1.30*0.79	1.30*0.99	1.30*0.96	1.30*0.43	1.30*-0.43	1.30*-0.30	1.30*-0.19	1.30*-0.77
	F. fly	0.28*0.99	0.28*0.05	0.28*0.56	0.28*0.42	0.28*-0.40	0.28*0.40	0.28*0.54	0.28*0.61	0.28*-0.98
	Aphids	0.84*-0.68	0.84*-0.81	0.84*-0.99	0.84*-0.97	0.84*-0.46	0.84*0.45	0.84*0.33	0.84*0.22	0.84*0.75
Agro	Thrips	1.26*-0.96	1.26*-0.82	1.26*0.99	1.26*0.92	1.26*0.27	1.26*-0.67	1.26*-0.90	1.26*0.83	1.26*0.69
	F. fly	0.21*-0.42	0.21*-0.96	0.21*0.63	0.21*0.89	0.21*0.91	0.21*-0.99	0.21*-0.26	0.21*0.96	0.21*-0.10
	Aphid	1.01*0.97	1.01*0.81	1.01*-1.00	1.01*-0.91	1.01*-0.25	1.01*0.64	1.01*0.91	1.01*-0.81	1.01*-0.71
Malik	Thrips	1.40*0.83	1.40*-0.56	1.40*-0.49	1.40*-0.43	1.40*0.39	1.40*-0.89	1.40*-0.56	1.40*-0.28	1.40*0.62
	F. fly	0.25*0.56	0.25*-0.99	0.25*-0.98	0.25*0.40	0.25*-0.44	0.25*-0.24	0.25*-0.99	0.25*0.54	0.25*-0.19
	Aphid	1.08*0.28	1.08*0.53	1.08*0.47	1.08*0.45	1.08*-0.41	1.08*0.91	1.08*0.53	1.08*0.31	1.08*-0.64

3.3 Correlation between proximate chemical composition of loofah leaves and insect pests

The insect pests responded variably to the chemical composition of fruits of four loofah varieties (Table 4). On Peshawar Local: the Thrips were negatively correlated with the moisture, ash, protein, fiber, Fe, Ca and Mg, while fruit fly to the ash, vitamins and fiber, and the aphids to the vitamins and Zn. On Chikni: the thrips and fruit fly were negatively correlated to the ash, proteins, fiber and Ca, while the aphids to the moisture, protein, Fe and Zn. On Agro: the thrips and fruit fly were negatively correlated to the ash, protein and fiber, while the aphids to the Fe, Zn and Ca. On Malik: the Thrips and fruit fly were negatively correlated to the moisture, vitamins, fiber, Fe and Mg, while the aphids to the ash only.

Table 4: Correlation among proximate chemical composition of loofah fruits and insect pests of four loofah cultivars during 2014.

Cultivar	Pest	Correlation of proximate chemical composition of loofah fruits and pests with								
		Moisture	Ash	Protein	Vitamin	Fiber	Fe	Zn	Ca	Mg
Pesh. Local	Thrips	1.41*-0.84	1.41* -0.89	1.41*-0.95	1.41*0.25	1.41*-0.82	1.41*-0.43	1.41*0.21	1.41* -0.27	1.41*-0.22
	F. fly	0.21*-0.13	0.21*-0.24	0.21*-0.39	0.21*-0.56	0.21*-0.10	0.21*0.40	0.21*-0.58	0.21*0.55	0.21*-0.89
	Aphids	0.83*0.85	0.83*0.91	0.83*0.96	0.83*-0.28	0.83*0.84	0.83*0.45	0.83*-0.26	0.83*0.30	0.83*0.20
Chikni	Thrips	1.30*0.99	1.30*-0.82	1.30*0.31	1.30*-0.56	1.30*-0.99	1.30*0.07	1.30*0.24	1.30*-0.56	1.30*-0.76
	F. fly	0.28*0.59	0.28*-0.96	0.28*-0.52	0.28*-0.99	0.28*-0.55	0.28*-0.71	0.28*0.52	0.28*-0.99	0.28*0.00
	Aphids	0.84*-0.99	0.84*0.81	0.84*-0.33	0.84*0.53	0.84*0.99	0.84*-0.09	0.84*-0.99	0.84*0.53	0.84*0.77
Agro	Thrips	1.26*-0.40	1.26*-0.56	1.26*-0.96	1.26*-0.07	1.26*-1.00	1.26*0.07	1.26*0.91	1.26*0.86	1.26*-0.10
	F. fly	0.21*0.43	0.21*-0.99	0.21*-0.42	0.21*0.71	0.21*-0.65	0.21*-0.71	0.21*0.27	0.21*0.94	0.21*-0.82
	Aphid	1.01*0.43	1.01*0.53	1.01*0.97	1.01*0.09	1.01*0.99	1.01*-0.09	1.01*-0.92	1.01*-0.85	1.01*0.07
Malik	Thrips	1.40*-0.56	1.40*0.42	1.40*-0.40	1.40*-0.48	1.40*-0.99	1.40*-0.26	1.40*-0.36	1.40*0.86	1.40*-0.29
	F. fly	0.25*-0.99	0.25*-0.41	0.25*0.43	0.25*-0.98	0.25*-0.58	0.25*-0.90	0.25*0.47	0.25*-0.99	0.25*-0.92
	Aphid	1.08*0.54	1.08*-0.44	1.08*0.42	1.08*0.46	1.08*0.99	1.08*0.24	1.08*0.39	1.08*0.63	1.08*0.27

Proximate and nutrient analysis of edible fruit and vegetables plays a crucial role in assessing their nutritional significance [16]. The considerable use of vegetable species by the local people in their diet motivated us to carry out the present proximate and nutrient analysis on *Allium sati-vum, Praecitrullus fistulosus, Luffa acutangla, Amaran-thus viridus, Abelmoschus esculentus, Chenopodium album, Momordica charatia* and *Spinacia oleraceae*. Besides their usage as food item, these vegetable species are also exploited for their medicinal properties. Most of these species are utilized against various diseases by the local communities through their indigenous knowledge. Proximate analysis of the loofah was determined as following: moisture (wet), moisture (dry), ash, fiber, protein, carbohydrate and fat were 92.45, 10.25, 8.00, 10.25, 13.43, 66.05 and 2.33. They further stated that it yielded 310 K cal energy per 100 gm [17].

4. Conclusion and Recommendations

Aphids, Thrips and fruit fly were the insect pests recorded on the four loofah cultivars in an earlier study [13]. Proximate chemical composition of loofah leaves and fruits yielded variable results for the four loofah cultivars and its correlation with the insect pests. Leaves and fruits of Malik (moisture, protein, vitamins, fiber) and Peshawar local (Fe, Zn, Ca, Mg) contained higher quantity of chemical contents than the other two varieties. Results of the present investigation may be utilized in developing a sustainable pest management strategy of insect pests of loofah in the agro-ecological system of Peshawar.

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