ANNUAL TECHNICAL REPORT

FOR THE YEAR

2019 – 2020

POST HARVEST RESEARCH CENTRE

AYUB AGRICULTURAL RESEARCH INSTITUTE

FAISALABAD

INTRODUCTION

Post Harvest Research Centre was established in 1989-90 with assistance of ADP/UNDP. The Post harvest technology deals with "produce management after harvesting till consumption" and to maintain quality during storage in order to obtain the maximum market price. The major objective of this Research Centre is to conduct Research and Development work on postharvest quality, safety and marketability of fresh horticultural produce and to extend the research based information to the farmers and exporters.

In 2008-9 Food Technology Section and Bio-Chemistry Section were brought under the umbrella of Post Harvest Research Centre. The Food Technology Section was established in 1968 with the objective to carry out research and development studies on processing, preservation and development of new value added products from various fruits and vegetables. This section has potentially contributed in value addition by developing food products and has trained thousands of human resources both male and female in food processing and preservation techniques. Pilot scale production and sale of various food products is another allied objective, helping to popularize the use of good quality food products among the masses, as well as to deposit handsome income annually to the government treasury.

Accordingly, Bio-Chemistry Section undertakes research, relating to nutritional evaluation of crops and provides analytical services to the farmers, scientists, industrialists and Research Institutions for quality testing of their research materials and products. It also evaluates nutritive values of different varieties of fodder crops for animal feeding and develops strategies for utilization of agro-industrial products, by-products and wastes.

OBJECTIVES

- To conduct R & D work on post harvest management & value addition of fruits & vegetables
- To develop and disseminate on-farm primary storage technology.
- Quality testing, evaluation and product development of new varieties
- To introduce grading & packing technology
- To introduce modern techniques in cold stores management.
- To conduct training & demonstration programs
- To render advisory services to enterprises & growers

ORGANIZATION

Name of Director: Mr. Anjum Javed

Other Technical Staff

Staff	Filled	Vacant	Total
Post Harvest			
Food Technologist (Physiology) BS-18+165	1	-	1
Food Technologist (G/P.S)) BS-18+165	1	-	1
Assistant Research Officer BS-17	3	-	3
Food Technology Section			
Food Technologist BS-18+165	1	-	1
Assistant Food Technologist BS-18	4	-	4
Assistant Research Officer BS-17	4	4	8
Bio-Chemistry Section			
Agricultural Chemist Bio BS -18+165	1	-	1
Assistant Chemist BS-18	1	-	1
Assistant Research Officer BS-17	5	-	5

BUDGET POSITION 2019-2020

Description	Allocation (M. Rs.)	Expenditure (M. Rs.)
Post Harvest		
Pay of officers	10.51194	10.51137
Pay of Establishment	9.369	9.363126
Allowance	14.7456	14.823133
Contingencies	5.947214	5.933621
Total	**40.573754**	**40.63125**
Biochemistry Section		
Pay of officers	6.2774	6.327020
Pay of Establishment	2.8402	2.825422
Allowance	7.4388	7.4547553
Contingencies	1.0006498	1.005512
Total	**17.562898**	**17.612707**

RESEARCH AND DEVELOPMENT WORK

POST HARVEST RESEARCH CENTRE

1. EFFECT OF LOW TEMPERATURE CONDITIONING ON THE STORAGE QUALITY OF PEAR FRUIT (*Pyrus Communis)*

Pear is rich in antioxidants, flavonoids and dietary fiber and helps in weight loss and reduces the risk of developing cancer, hypertension, diabetes and heart disease. Appearance of rapid postharvest browning in fruit peel and core during storage and short life span pose a challenge for their marketing. This trial was conducted to investigate the potential of low temperature conditioning (LTC) to inhibit peel browning in pear fruit and to improve quality of pear in storage and to extend shelf life. Pear (promising variety) was harvested at mature stage from orchard. Pears were transported to PHRC laboratory. Fruit was sorted for uniformity of size and appearance. The fruits were given a low temperature conditioning at 8˚C for 1, 3, 6, and 9 days respectively. Fruits without LTC treatment were regarded as control. All the fruits were stored at 0˚C$\pm$1˚Cfor acceptable period. Fruits were taken out for browning and quality evaluation every 7 days and data regarding weight loss %, firmness, pH, TSS, acidity was noted. Pear fruit kept at 8 ^{0}C for 6 days (T4) showed better result in a storage study of 42 days. Table: 1.

2. IMPACT OF MODIFIED ATMOSPHERIC PACKAGING ON SHELF LIFE OF FRESH CUT BITTER GOURD

Changes in lifestyle patterns has increased demand of fresh cut vegetables as people don't have time to prepare vegetables at home as well as in hotels. Because of these factors consumption of minimally processed products has significantly increased. So this trial was performed to enhance the shelf life and to extend the marketing span of fresh cut bitter gourd. Bitter gourd of good quality and uniform size at mature stage was harvested from the Vegetable Research Institute. After harvesting bitter gourd was stored at 8 ^{0}C for 2 hrs before further processing. Bitter gourd was sliced with sharp sterilized stainless steel knife into 1 cm thick cubes and then dipped these cubes into sodium hypochlorite solution (100 ppm for 3 min) to reduce microbial load. After subsequent drying, packed into different packaging material (Low density polyethylene (LDPE), High density polyethylene (HDPE) and Polypropylene(PP)) and stored at 8˚C$\pm$0.5˚C and 90-95% relative humidity for acceptable period. Fruits were taken out for quality evaluation after 3 days interval and data regarding weight loss %, chlorophyll, acidity, ascorbic acid and color was noted. Fresh cut Bitter gourd packed in Low density polyethylene (LDPE) showed better result

up to 2 weeks of storage as little changes were observed in chlorophyll contents and ascorbic acid followed by T_4 (PP) and T_3 (HDPE) respectively. Table:2.

3. EFFECT OF HOT WATER TREATMENT ON PAPAYA POST HARVEST QUALITY AND ENZYME ACTIVITY DURING LOW TEMPERATURE STORAGE

Papaya is a tropical fruit that possesses good nutritional quality attributes but may suffer some post harvest handling problems due to its susceptibility to decay and insect pests. So to control the softening of fruit by inhibiting enzyme activity of pectin methylesterase and polygalacturonase hot water treatment was given. Papaya fruit of promising variety at color break stage was procured from the orchard. The fruit was screened based on uniformity of shape, size and peel color and any defected fruits were discarded. The fruit was immersed in hot water (HWT) at 55 ^{o}C for 3, 6 and 9 minutes. Immediately after the HWT the fruits were cooled at 25 ^{0}C within 20 min. Then papaya fruit was wrapped in shrink polyethylene films and stored at 12˚C$\pm$1˚C and 85-90% relative humidity for acceptable period. Fruits were taken out for quality evaluation after 5 days interval and data regarding weight loss %, decay on skin, firmness, pH, TSS, acidity, and color was noted. Enzyme activity PME and PG was also be calculated at the end of storage period. HWT at 55 ^{0}C for 6 minutes (T_3) showed better retention of quality parameters and delayed decay development during papaya storage up to 3 weeks followed by HWT at 55 ^{0}C for 3 minutes (T_2) , however HWT for 3,6 and 9 minutes did not affect the softening process from papaya pulp. Table: 3.

4. THE EFFECTS OF SALICYLIC ACID AND CINNAMON OIL APPLICATION ON POSTHARVEST QUALITY OF PEACH DURING STORAGE

Because of increasing concerns about chemical usage in food and the environment, there is also renewed interest in nonchemical approaches to postharvest disease control. There is therefore still a need for new and effective natural antimicrobials of reducing or eliminating fungus. In nature, essential oils play an important role in the protection of the plants as antibacterial, antiviral, antifungal, insecticides and also against herbivores by reducing their appetite for such plants. Salicylic acid (SA) is a plant hormone inhibiting ethylene biosynthesis and delaying the senescence. SA being an endogenous growth regulator from phenolic group has been extensively used for quality improvement in a number of crops. Salicylic acid has been documented to enhance flesh firmness of harvested peaches. So this trial was designed to evaluate the effects of postharvest salicylic acid and cinnamon essential oil application on post harvest disease control and quality parameters and to maintain quality of peach in storage and to extend

shelf life. Peach fruits (*Prunns persica* L.) were harvested at physiologically mature stage from a commercial orchard. The fruit was screened based on uniformity of shape, size and peel color and any defected fruits were discarded. The fruits were divided into five lots and treated by dipping in the solution of salicylic acid (1Mm and 2mM) and cinnamon essential oil (250 ppm and 500 ppm) for 5 min at 25ºC. All the fruits were stored at 5˚C±1˚C at 85-90% relative humidity for acceptable period. Fruits were taken out for quality evaluation after every 3 days and data regarding weight loss %, firmness, pH, TSS, acidity and color was noted. Peach fruit treated with 2 mM Salicylic Acid and 250 ppm cinnamon oil perform good during storage in maintaining quality upto acceptable level for 28 days. Table: 4.

5. PHYSIOLOGICAL RESPONSE OF OKRA TO 1-MCP (1-Methyl Cyclopropane) AND MODIFIED ATMOSPHERE PACKAGING (MAP)

Okra (*Hibiscus esculentus* L.) is a vegetable of high nutritional values. Improper post-harvest handling and storage under room temperature lead to high loss of moisture and green color that result in loss of strength in okra tissues. Whereas, storage at low temperature delayed fruit senescence but the beneficial effects may be limited due to the development of chilling injury-associated disorders. Therefore, reduction of chilling injury development is an effective way to extend storage life and to maintain quality of okra. This experiment was conducted to improve quality attributes of Okra by applying 1 MCP and to study the impact of Modified Atmospheric Packaging (MAP) on the quality retention of Okra. Okra was harvested at mature stage from the Vegetable Research Institute, AARI. After manual grading and sorting, treatment of 1-MCP (5 µL/L 1-MCP at 20^0C for 16 hours) was applied, then vegetable was packed in 0.03 mm thick perforated (1 mm diameter 3 holes per bag) polyethylene bags. No. of holes per bag was determined on the basis of weight of sample. All the vegetable was stored at ambient conditions and in cold store at 7^0C± 1^0C and 80-85% Relative Humidity for up to the maximum acceptable period. Data regarding weight loss %, firmness, respiration rate, decay % and color was determined after 4 days interval. Okra treated with 1-MCP remarkably controlled the quality parameters (respiration rate, weight loss and firmness). In addition, 1-MCP and MAP treatments inhibited the changes in green color of Okra. The maximum storage period was observed upto 20 days. Overall best performance/results were observed in T4 (okra treated with 1-MCP packed in MAP and stored at 7 °C). Table: 5.

6. DEVELOPMENT AND OPTIMIZATION OF THERAPEUTIC HERBAL TURMERIC DRINK

Turmeric (Curcuma longa) is an ancient spice and a native of South East Asia. It is used as a condiment and as a culinary dye. Turmeric is a rhizome resembling ginger. It is yellowish-brown with a dull orange interior and usually produces a bright yellow powder when ground. Turmeric detoxifies the body mind and in this way helps the body cure itself. One sure sign of this is that it increases the level of the enzyme glutathione S-transferase (GST), which is essential to detoxification. Turmeric is one of the 10 best herbs to treat poisoning and to purify. Turmeric is a great carminative, able to calm an upset digestive system by getting rid of gas and distention, normalize metabolism, to help digest protein, and to increase the bio-availability of food. Fresh turmeric (Curcuma longa) and spices (cardamom and fennel seeds) was procured from local market. After washing and peeling the extract of turmeric was prepared according the percentage of treatments by boiling the turmeric in 100 ml of water for 15 minutes. The extract of spices was also prepared with same procedure. The extract so obtained was filtered through the muslin cloth to get clear extract. This clear and filtered extracts was stored at refrigerated temperature in plastic sterilized bottles for further utilization. The stored filtered extract of turmeric (100%, 80%, 60%, 40% and 30%) and spices (2%) were mixed through blending machine according the treatment plan. Pasteurization was done after adding sugar, preservatives color and Vit. C @ 0.1% of the drink. The drink was prepared by mixing the carbonated water according to the standard formula. The brix of each treatment was maintained approx. 12.0 and filled in glass bottles. The samples so obtained were stored at ambient temperature to evaluate the storage behavior of all the treatments. Physico-chemical parameters i.e., TSS, Total phenolics %, acidity, pH of prepared samples was carried out after 15 days up to maximum storage life. Organoleptic evaluation was also carried out throughout storage. Turmeric drink prepared with 60% turmeric extract (T3) ranked best in organoleptic evaluation and showed better storage attributes.

Table: 6-7

7. KIWI FRUIT VALUE ADDITION/PROCESSED PRODUCTS WITH NON NUTRITIVE SWEETENER IN PLACE OF SUGAR

The kiwifruit (*Actinidiadeliciosa*) is an exotic fruit belonging to the family Actinidiaceae. This fruit is packed with healthy amount of health promoting nutrients. It is rich in vitamin C, a powerful antioxidant, protects the body against cell damaging of free radicals, have considerable amount of Vit. E, Vit. K, soluble and insoluble fiber, flavonoids, major phytochemical include

Lutein, β carotene, violaxanthin and neoxenthin. As the storage quality of whole fruit cannot be maintained for long period of time, improvement in the post harvest processing will enhance the effective utilization of the fruit. The fruit has excellent aroma and has great potential for processing into various products drink, squash and jam. This trial was conducted to develop value added products of kiwi fruit with non-nutritive sweetener. Kiwi fruit was procured from local market and processed into pulp through pulper. There after the pulp was processed into different products like jam, squash and ready to serve beverage according to the product specification. Fresh kiwi fruit was analyzed for TSS, pH, Acidity % total sugars%, K, Fe and Mn. The prepared samples were subjected to different physico-chemical analysis i.e. TSS, %acidity, pH, total sugars%, mineral i.e. Fe, K, Mn and vitamin C after 15 days interval and for jam after 30 days interval during storage. The organoleptic evaluation for color, flavor, taste and overall acceptability was carried out after the same interval. Jam prepared with sucrose (T_1) performed best in storage and have better sensory attributes compared to artificial sweetners. Kiwi squash (T6) and kiwi drink (T9) containing aspartame have better sensory and quality attributes. The sweeteners aspartame showed a sensory profile similar to sucrose, sensory evaluation panel preferred the samples sweetened with aspartame which received the highest scores for the attributes flavor, texture, and the overall impression. These results have proved that aspartame is the best sucrose substitutes and did not present bitter taste, bitter aftertaste, and metallic taste. Table: 8-13.

8. MEDICINAL VALUE ADDITION OF APPLE JAM

Objective of this trial was the development and optimization of medicinally enriched standard and diet Apple jam. It was planned to add some of the medicinal plants/extracts separately like Black pepper (an anti-inflammatory, carminative, anti-flatulent, aromatic and increase the absorption of Se and B-complex vitamins) Mint (antioxidant antiseptic, digestion and for irritable bowel syndrome), Cinnamon (anti-arthritis, anti-septic, anti- diabetic), Aloe vera (antioxidant, antiseptic particularly for sores, sunburns and other burns) and thyme (strong antiseptic & antioxidants and flavor boosting). This fortification was enhance not only the bioavailability of nutrients present in apple jam but also augment the medicinal value so that the product may act beyond merely the jam. Cooking or heating was carried till the jam gets 70^0 Brix according to standard formula. Batch of diet jam was prepared accordingly by adding respective sweetener instead of sugar. Medicinal herbs were added near to the completion of cooking to avoid heat damage of bioactive compounds. Organoleptic evaluation , pH, acidity,

sugars and TSS was carried out weekly for 6 months. It could be concluded from the results that the Medicinal herbs/spices added apple jam has good stability in the context of biochemical parameters during the storage of six months. Organoleptic analyses indicated the acceptability of the product with and without sugar (i.e., sweetener) which is a good sign for introduction of the new product in the market. All the types of apple jam scored above six points on hedonic scale which indicates that product is stable up to six months storage time at ambient temperature and acceptable organoleptically. Fruit jams are an essential breakfast item for almost every household. If taste could be developed for medicinal herbs/spices added apple jam, different health problems related to respiratory and gastrointestinal tracts could be addressed through food by avoiding medicine specially in children. Diabetic patients can enjoy apple jam with sweetener along with cinnamon (blood sugar lowering properties) and aloevera (dietary fiber) health benefits. Table: 14- 19.

9. IMPACT ASSESSMENT OF TRAINING ON FOOD PRESERVATION AND PROCESSING

This experiment was designed to study the demographic attributes of trainees, to assess the impact of training programme and to obtain the feedback of trainees for improving future training programmes. Evaluation of trainees (participating in trainings at AARI campus and various vocational institutes of Punjab) will be done through a questionnaire at the start of training and at the end of training by applying KASA model (knowledge, attitude, skills and aspiration). This model assumes that change in knowledge, attitude, skills and aspiration leads to modification in practices and desired change. Gain in knowledge of trainees will be worked out by computing the differences between pre and post trainings knowledge score. Results regarding demographic attributes of the participants are presented in Table 20. Major percentage of participants (69.52%) was below 25 years of age. Only 3.80% participants were above 30 years and remaining was 25-30.

• Major proportion of the participants (57.14%) was having secondary education. Participants having education up to higher secondary and graduation level were 20 and 15.23%, respectively. Only 7.61% females were having education up to Masters level.

• Pre and post-training knowledge of the participants regarding food safety and balanced food was checked by different questions.

• It is indicated from the results that pickling and freezing were the food preservation techniques, the participants were most familiar (69.52 and 77.14%, respectively) before training. None of the participants were having knowledge of canning and only 5.71 and 7.62% were knowledge of salting and drying. Percentage of participants increased having knowledge of food preservation techniques increased after attending the training.

• Regarding food safety, 40% participants were considering it as food free from microbes while, only 12.38% were having idea of food free from heavy metals before training.

• About the concept of balanced food, a satisfactory percentage (84.76%) of participants was having knowledge of concept of balanced diet having proteins, carbohydrates and fats along with essential vitamins and minerals before training and this portion further increased up to 86.67%.

• Only 46.67% of trainees were having idea of infected food before training and after getting trained, 98.10% of participants were clear about infected food. 27.62% of participants were having information how to control of infection of food and after training, 88.57% of the trainees were having idea of controlling food infection.

• Only 6.67 and 7.62% of the trainees knew about role of salt and sugar in food preservation before training and this percentage was increased up to 37.14 and 33.33%, respectively. Regarding food security, 20% of the trainees were taking food security as food safety i.e., considering food free from microbes as food security before training.

• Results pertaining to knowledge of trainees regarding different food preparation are presented in Table 22.

• None of the participants were having knowledge how to prepare apple jam, lemon barley and strawberry squash before training and after attending training, 86.67, 94.29 and 84.76% of trainees were knowing how to prepare apple jam, lemon barley and strawberry squash. 16.19% trainees knew how to make pickle before training while, after training 90.48% trainees got knowledge about pickling technique.

• At the end of training, trainees were asked to give their suggestions for improvement of training programme and results about their propositions are presented in Table 23.

• All of the trainees (100%) were satisfied with the methodology adopted by staff for delivering lecture and practical demonstration as well as with the behaviour of the training staff. Major proportion of the trainees (91.43%) suggested for increasing the duration of training for a weak so as to get more practical knowledge of preparing food items.

• 90.48% participants submitted to advertise training venue and schedule on local tv channels or newspapers. Only 20.95% trainees proposed to cover marketing aspect of the food items. This may be due to less number of participants getting training as entrepreneurs. Table 20-23.

TABLES: 1-23

Table: .1	EFFECT OF LOW TEMPERATURE CONDITIONING ON THE STORAGE QUALITY OF PEAR FRUIT											
TSS %	**Treatments**	**Storage Days**										
		0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**135**	**150**	**Mean**
	T1	9.40	9.44	10.60	11.00	11.80	12.60	13.80	14.90	16.80	17.00	17.20	**13.14a**
	T2	9.60	9.80	10.10	10.40	10.80	11.40	12.00	12.50	13.00	13.80	14.40	**11.62b**
	T3	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00	9.20	**8.61d**
	T4	6.70	6.80	6.90	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	**7.20e**
	T5	9.00	9.10	9.30	9.40	9.60	9.80	10.10	10.80	11.00	12.20	12.40	**10.25c**
	Mean	**8.56**	**8.67**	**9.04**	**9.24**	**9.56**	**9.92**	**10.38**	**10.88**	**11.44**	**11.92**	**12.18**	
	Treatments	**Days**											
		0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**135**	**150**	**Mean**
	T1	8.26	8.11	7.24	6.55	6.23	5.27	5.58	4.26	3.06	3.34	3.02	**5.54e**
	T2	8.24	8.20	7.74	7.20	6.24	6.14	5.78	5.21	4.76	4.18	3.48	**6.11d**
	T3	8.24	8.22	7.92	7.36	7.08	6.88	6.34	6.14	5.82	5.14	4.24	**6.67c**
	T4	8.25	8.22	8.20	8.14	8.08	7.86	7.74	7.64	7.56	7.34	6.86	**7.81a**
	T5	8.26	8.24	8.20	8.14	8.02	7.86	7.68	7.24	5.82	5.26	4.86	**7.23b**
	Mean	**8.25**	**8.20**	**7.86**	**7.48**	**7.13**	**6.80**	**6.62**	**6.10**	**5.40**	**5.05**	**4.49**	
Weight Loss	**Treatments**	**Days**											
		0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**135**	**150**	**Mean**
	T1	0	1.24	2.88	4.54	6.82	8.72	10.76	11.78	12.84	13.15	13.98	**7.88a**
	T2	0	1.16	2.48	3.64	4.54	5.78	6.46	7.8	8.88	9.13	9.52	**5.4b**
	T3	0	0	0.3	1.56	2.59	2.89	3.28	3.68	4.21	4.72	5.54	**2.62d**
	T4	0	0	0.01	0.1	1.03	1.05	1.65	1.93	2.1	2.92	3.01	**1.25e**
	T5	0.00	0.76	1.86	2.88	3.56	3.98	4.8	5.48	5.94	6.86	7.9	**4.00c**
	Mean	**0.00**	**0.11**	**0.31**	**0.52**	**0.87**	**1.18**	**1.29**	**1.72**	**1.82**	**2.08**	**2.36**	
Acidity	**Treatments**	**Days**											
		0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**135**	**150**	**Mean**
	T1	0.61	0.58	0.51	0.42	0.35	0.30	0.26	0.28	0.24	0.20	0.18	**0.35d**
	T2	0.59	0.55	0.52	0.50	0.48	0.42	0.40	0.35	0.30	0.32	0.34	**0.43c**
	T3	0.61	0.57	0.55	0.54	0.52	0.52	0.50	0.48	0.45	0.42	0.4	**0.51b**
	T4	0.66	0.64	0.62	0.6	0.58	0.56	0.54	0.52	0.50	0.48	0.48	**0.56a**
	T5	0.58	0.56	0.54	0.52	0.50	0.48	0.46	0.44	0.45	0.42	0.40	**0.49b**
	Mean	**0.61**	**0.58**	**0.55**	**0.52**	**0.49**	**0.46**	**0.43**	**0.41**	**0.39**	**0.37**	**0.36**	

Table: .2 IMPACT OF MODIFIED ATMOSPHERIC PACKAGING ON SHELF LIFE OF FRESH CUT BITTER GOURD

	Treatm	Storage Days					
		0	3	6	9	12	Mean
Weight Loss	T1	0.00	4.00	5.80	8.80	10.50	**5.82**
	T2	0.00	2.10	2.50	3.60	5.20	**2.68**
	T3	0.00	3.90	4.10	7.40	8.40	**4.76**
	T4	0.00	3.10	3.40	5.30	6.40	**3.64**
	Mean	**0.00**	**3.28**	**3.95**	**6.28**	**7.63**	

	Treatm	Days					
		0	3	6	9	12	Mean
Cholophyll	T1	21.57	18.50	12.50	10.70	9.50	**14.55**
	T2	21.57	20.20	16.20	14.30	12.40	**16.93**
	T3	21.57	18.90	13.80	9.30	11.50	**15.01**
	T4	21.57	19.50	14.50	13.90	11.90	**16.27**
	Mean	**21.57**	**19.28**	**14.25**	**12.05**	**11.33**	

	Treatm	Days					
		0	3	6	9	12	Mean
Acidity	T1	0.65	0.85	0.98	1.01	1.50	**1.00**
	T2	0.66	0.81	0.85	0.92	0.96	**0.84**
	T3	0.66	0.84	0.91	1.05	1.20	**0.93**
	T4	0.65	0.83	0.89	0.95	0.99	**0.86**
	Mean	**0.66**	**0.83**	**0.91**	**0.98**	**1.16**	

	Treatm	Days					
		0	15	30	45	60	Mean
Ascorbic Acid	T1	70.25	58.30	55.30	51.20	49.80	**56.97**
	T2	70.25	66.80	63.40	62.40	61.20	**64.81**
	T3	70.25	59.60	57.20	53.70	55.30	**59.21**
	T4	70.25	63.20	61.70	60.50	59.70	**63.07**
	Mean	**70.25**	**61.98**	**59.40**	**56.95**	**56.50**	

Table 3 EFFECT OF HOT WATER TREATMENT ON PAPAYA POST HARVEST QUALITY AND ENZYME ACTIVITY DURING LOW TEMPERATURE STORAGE

		Storage Days					
Firmness	**Treatments**	**0**	**7**	**14**	**21**	**28**	**Mean**
	T1	12.98	11.53	10.63	9.92	8.79	10.77
	T2	12.76	12.14	11.83	11.05	10.72	11.70
	T3	12.96	12.65	12.20	11.97	11.12	12.18
	T4	12.93	12.29	11.95	11.51	11.03	11.94
	Mean	12.91	12.15	11.65	11.11	10.42	11.65
		Storage Days					
TSS	**Treatments**	**0**	**7**	**14**	**21**	**28**	**Mean**
	T1	5.20	5.50	6.20	7.30	7.61	6.36
	T2	5.50	5.80	6.10	6.50	6.98	6.18
	T3	5.40	5.60	5.90	6.00	6.11	5.80
	T4	5.30	5.70	6.10	6.30	6.53	5.99
	Mean	5.35	5.65	6.08	6.53	6.81	6.08
		Storage Days					
wt. loss %	**Treatments**	**0**	**7**	**14**	**21**	**28**	**Mean**
	T1	0.00	6.20	9.34	11.20	13.50	8.05
	T2	0.00	5.16	7.18	9.91	10.89	6.63
	T3	0.00	2.72	4.89	6.33	8.75	4.54
	T4	0.00	3.38	6.35	8.85	10.38	5.79
	Mean	0.00	4.37	6.94	9.07	10.88	6.25
		Storage Days					
acidity %	**Treatments**	**0**	**7**	**14**	**21**	**28**	**Mean**
	T1	1.53	0.98	0.74	0.53	0.01	0.76
	T2	1.55	1.09	0.93	0.41	0.03	0.80
	T3	1.59	1.21	1.05	0.99	0.69	1.11
	T4	1.56	1.15	0.94	0.57	0.15	0.87
	Mean	1.56	1.11	0.92	0.63	0.22	0.89
		Storage Days					
decay %	**Treatments**	**0**	**7**	**14**	**21**	**28**	**Mean**
	T1	0.00	8.00	11.21	20.90	35.40	15.10
	T2	0.00	2.00	5.61	9.23	10.14	5.40
	T3	0.00	0.00	0.00	3.74	7.35	2.22
	T4	0.00	0.00	3.11	7.19	8.65	3.79
	Mean	0.00	2.50	4.98	10.27	15.39	6.63

Table: 4	The Effect of Salicylic Acid and Cinnamon Oil Application on Post Harvest Quality of Peach During Storage									
TSS %	Treatmen	Storage Days								
		0	4	8	12	20	24	28	Mean	
	T1	7.96	9.66	10.86	11.64	12.82	13.36	13.94	11.46a	
	T2	7.96	8.62	9.58	10.22	11.34	12.44	12.72	10.41b	
	T3	7.98	8.64	8.84	9.64	9.74	9.86	10.58	9.33c	
	T4	7.2	7.24	7.28	7.32	7.36	7.4	7.42	7.32e	
	T5	7.68	7.74	8.36	8.34	8.44	8.62	9.04	8.32d	
	Mean	7.76	8.38	8.98	9.43	9.94	10.34	10.74		
Firmness	Treatmen	Days							Mean	
		0	4	8	12	20	24	28		
	T1	5.6	3.2	3	2.9	2.56	2.2	1.78	3.03e	
	T2	5.74	4.1	3.84	3.1	2.9	2.6	2.42	3.52d	
	T3	5.72	4.88	4.26	4.18	3.89	3.8	3.64	4.34c	
	T4	6	5.96	5.86	5.3	5.18	5.02	4.86	5.45a	
	T5	5.84	5.58	4.84	4.44	4.24	4.4	4.2	4.79b	
	Mean	5.78	4.74	4.36	3.98	3.754	3.60	3.38		
Weight Loss	Treatmen	Days							Mean	
		0	4	8	12	20	24	28		
	T1	0	7.24	7.96	8.46	9.86	10.04	11.16	7.81a	
	T2	0	5.34	5.64	5.9	6.7	8.1	11.5	6.16b	
	T3	0	5.1	5.46	5.62	5.84	6.22	6.66	4.98c	
	T4	0	2.2	2.8	3.14	4.24	5.1	6.56	3.43d	
	T5	0	3.88	4.9	5.16	5.86	5.88	6.14	4.54cd	
	Mean	0.00	4.75	5.35	5.66	6.50	7.07	8.40		
Acidity	Treatmen	Days							Mean	
		0	4	8	12	20	24	28		
	T1	0.84	0.74	0.68	0.58	0.5	0.48	0.46	0.61d	
	T2	0.9	0.74	0.68	0.66	0.64	0.6	0.62	0.69c	
	T3	0.92	0.9	0.76	0.72	0.7	0.68	0.66	0.73bc	
	T4	0.96	0.94	0.92	0.88	0.80	0.78	0.70	0.85a	
	T5	0.94	0.92	0.78	0.76	0.74	0.7	0.68	0.78b	
	Mean	0.912	0.848	0.764	0.72	0.676	0.648	0.624		
pH	Treatmen	Days							Mean	
		0	4	8	12	20	24	28		
	T1	4.96	5.16	5.24	5.42	5.66	5.88	6.39	5.53a	
	T2	4.92	5.02	5.16	5.28	5.42	5.58	5.66	5.29b	
	T3	4.88	4.92	4.96	5.1	5.16	5.26	5.34	5.08c	
	T4	4.68	4.7	4.74	4.8	4.82	4.86	4.88	4.78d	
	T5	4.88	4.92	4.98	5.04	5.1	5.14	5.18	5.03c	
	Mean	4.864	4.944	5.016	5.128	5.232	5.344	5.49		

Table: 5	PHYSIOLOGICAL RESPONSE OF OKRA TO 1-MCP AND MODIFIED ATMOSPHERE PACKAGING							
		Storage Days						
Firmness	Treatments	0	4	8	12	16	20	Mean
	T1	0.69	0.59	0.52	0.47	0.41	0.36	**0.51 c**
	T2	0.69	0.61	0.52	0.46	0.41	0.35	**0.51 c**
	T3	0.69	0.45	0.33	0.00	0	0	**0.49 d**
	T4	0.69	0.63	0.59	0.51	0.46	0.39	**0.55 a**
	T5	0.69	0.54	0.39	0.00	0	0	**0.54 b**
	Mean	**0.69**	**0.56**	**0.47**	**0.29**	**0.26**	**0.22**	**0.52**
					CV			
		Storage Days						
Vitmin C(mg/100g	Treatments	0	4	8	12	16	20	Mean
	T1	21.53	15.71	14.72	13.37	11.20	8.59	**14.19 e**
	T2	21.53	18.29	14.48	13.55	11.64	7.22	**14.45 d**
	T3	21.53	16.39	10.29	0.00	0.00	0.00	**16.07 c**
	T4	21.53	19.37	17.54	15.42	12.74	11.83	**16.41 b**
	T5	21.53	18.07	11.32	0.00	0.00	0.00	**16.97 a**
	Mean	**21.53**	**17.57**	**13.67**	**8.47**	**7.12**	**5.53**	**15.62**
					CV			
		Storage Days						
Respiration Rate	Treatments	0	4	8	12	16	20	Mean
	T1	345.79	278.90	319.05	341.57	375.29	407.34	344.66 c
	T2	345.79	275.31	321.17	338.32	368.20	404.11	342.15 d
	T3	345.79	411.15	533.51	0.00	0.00	0.00	430.15 a
	T4	345.79	267.21	302.79	326.42	353.55	383.90	329.94 e
	T5	345.79	388.50	496.12	0.00	0.00	0.00	410.14 b
	Mean	**345.79**	**324.21**	**394.53**	**201.26**	**219.41**	**239.07**	**371.41**
					CV			
		Storage Days						
Chilling Injury (%	Treatments	0	4	8	12	16	20	Mean
	T1	0	0.7	1	1.7	2.3	2.8	1.42 a
	T2	0	0.5	0.7	1.3	1.6	2.3	1.07 b
	T3	0	0	0	0	0	0	0
	T4	0	0	0.4	0.6	0.8	1.2	0.50 c
	T5	0	0	0	0	0	0	0
	Mean	**0.00**	**0.24**	**0.42**	**0.72**	**0.94**	**1.26**	0.6
					CV			
		Storage Days						
Weight Loss (%)	Treatments	0	4	8	12	16	20	Mean
	T1	0	5.21	7.17	10.95	11.98	13.55	**8.14 b**
	T2	0	4.79	6.62	9.91	11.87	13.39	**7.76 c**
	T3	0	8.66	18.80	0.00	0.00	0.00	**9.15 a**
	T4	0	1.60	4.50	6.60	7.31	9.93	**4.99 e**
	T5	0	6.28	14.91	0.00	0.00	0.00	**7.06 d**
	Mean	**0.00**	**5.31**	**10.40**	**5.49**	**6.23**	**7.37**	**7.42**
		Storage Days						
Color "L"	Treatments	0	4	8	12	16	20	Mean
	T1	39.33	37.79	34.21	30.29	27.59	24.42	32.27 c
	T2	39.33	37.93	34.07	31.11	28.13	24.91	32.58 b
	T3	39.33	32.63	24.82	0.00	0.00	0.00	32.26 c
	T4	39.33	38.51	35.63	33.36	31.50	26.56	34.15 a
	T5	39.33	33.96	27.54	0.00	0.00	0.00	33.61 d
	Mean	**39.33**	**36.16**	**31.25**	**18.95**	**17.44**	**15.18**	26.3
		Storage Days						
Color "a"	Treatments	0	4	8	12	16	20	Mean
	T1	18.45	18.53	18.65	19.23	19.90	20.29	19.18 a
	T2	18.45	18.54	18.63	19.41	19.96	20.36	19.23 b
	T3	18.45	18.84	20.43	0.00	0.00	0.00	19.24 b
	T4	18.45	18.49	18.59	18.86	19.40	20.08	18.98 d
	T5	18.45	18.68	19.93	0.00	0.00	0.00	19.02 c
	Mean	**18.45**	**18.62**	**19.25**	**11.50**	**11.85**	**12.15**	15.3
					CV			
		Storage Days						
Color "b"	Treatments	0	4	8	12	16	20	Mean
	T1	-10.15	-10.10	-9.91	-8.94	-8.11	-7.33	**-9.09**
	T2	-10.15	-10.11	-9.77	-8.58	-8.01	-7.30	**-8.986666667**
	T3	-10.15	-9.44	-7.46	0.00	0.00	0.00	**-9.016666667**
	T4	-10.15	-10.13	-10.02	-9.24	-8.92	-7.84	**-9.383333333**
	T5	-10.15	-9.90	-8.11	0.00	0.00	0.00	**-9.386666667**
	Mean	**-10.15**	**-9.94**	**-9.05**	**-5.35**	**-5.01**	**-4.49**	**-7.332333333**

Table = 6	Development and Optimization of Therapeutic Herbal Turmeric Drink							
Treatments	**TSS (Brix^{o})**							**Means**
	Storage Period (days)							
	0	**15**	**30**	**45**	**60**	**75**	**90**	
T_1	14.55	14.62	14.76	14.94	15.38	15.46	15.68	15.05a
T_2	14.5	14.6	14.8	14.71	14.74	15.02	15.4	14.82b
T_3	14.16	14.2	14.32	14.42	14.5	14.54	14.58	14.38d
T_4	14.4	14.18	14.38	14.46	14.54	15.18	15.24	14.62c
T_5	14.11	14.25	14.54	14.62	14.7	14.82	14.84	14.55cd
Means	**14.34e**	**14.37de**	**14.56cd**	**14.63bc**	**14.77b**	**15.00a**	**15.15a**	
Treatments	**pH**							**Means**
T_1	3.82	3.75	3.72	3.71	3.65	3.61	3.56	**3.68a**
T_2	3.68	3.65	3.61	3.57	3.54	3.51	3.47	**3.57b**
T_3	3.6	3.55	3.5	3.47	3.43	3.4	3.35	**3.47d**
T_4	3.63	3.6	3.58	3.55	3.51	3.47	3.44	**3.52c**
T_5	3.66	3.63	3.58	3.56	3.51	3.47	3.43	**3.54bc**
Means	**3.67a**	**3.63b**	**3.59c**	**3.57d**	**3.52e**	**3.49f**	**3.45g**	
Treatments	**% Acidity**							**Means**
T_1	0.69	0.71	0.74	0.78	0.82	0.91	0.97	**0.80a**
T_2	0.64	0.66	0.72	0.76	0.79	0.84	0.99	**0.77b**
T_3	0.48	0.5	0.56	0.58	0.64	0.78	0.82	**0.62d**
T_4	0.57	0.62	0.66	0.71	0.78	0.83	0.88	**0.72c**
T_5	0.61	0.65	0.67	0.71	0.76	0.8	0.86	**0.72c**
Means	**0.60f**	**0.63f**	**0.67e**	**0.70d**	**0.75c**	**0.83b**	**0.90a**	
Treatments	**Total Phenolics (%)**							**Means**
	Storage Period (days)							
	0	**90**						
T_1	7.7	7.4						**7.55a**
T_2	5.36	5.18						**5.27b**
T_3	5.3	5.12						**5.21b**
T_4	4.32	4.14						**4.23c**
T_5	4.25	4.06						**4.15c**
Means	**5.386**	**5.18**						

Table 7. Sensory Evaluation of Therapeutic Herbal Turmeric Drink

Color								
Treatment	**Storage Period (days)**							**Means**
	0	**15**	**30**	**45**	**60**	**75**	**90**	
T_1	7.2	7.2	6.8	6.5	6.2	6.2	5.8	**5.94c**
T_2	7.4	7.3	6.7	6.6	6.4	6.2	5.6	**6.57b**
T_3	7.8	7.8	6.8	6.8	7.2	6.8	5.2	**7.20a**
T_4	7.4	7.3	6.7	7.6	6.4	6.2	5.4	**6.97a**
T_5	8.2	8.2	6.8	6.8	6.2	6	5.8	**6.57b**
Mean	**7.20a**	**7.16ab**	**6.68c**	**6.76bc**	**6.48cd**	**6.20d**	**6.08d**	
Flavor								
T_1	6.6	6.4	6.4	5.6	5.8	5.6	5.2	**5.94c**
T_2	6.6	6.6	7	6.8	6.4	7.6	7.6	**6.94b**
T_3	8.2	8	7.6	7.8	7	7.8	7.4	**7.69a**
T_4	8.2	7.8	7.8	7.6	5.2	5.4	5.8	**6.83b**
T_5	7.4	7.4	7.2	7.2	7	6.8	6.6	**7.09b**
Mean	**7.40a**	**7.24ab**	**7.20ab**	**7.00b**	**6.28d**	**6.64c**	**6.52cd**	
Taste								
T_1	6.2	6.2	5.6	5.6	5.8	5.6	6	**5.86c**
T_2	6.2	6.2	6.4	6.8	6.4	8	7	**6.71b**
T_3	7.8	8.2	7.6	6.8	8	7.6	7.6	**7.66a**
T_4	8.2	8.2	7.6	7.6	7.8	7.8	8	**7.89a**
T_5	7.6	7.4	6.4	7	7	6.4	6.4	**6.89b**
Mean	**7.20a**	**7.24a**	**6.72c**	**6.76bc**	**7.00abc**	**7.08ab**	**7.00abc**	
Overall acceptability								
T_1	7.2	6.2	6.4	7.4	6.8	6.4	7.6	**6.86d**
T_2	7.2	7.4	7.6	6.4	6.8	7.4	6.8	**7.09cd**
T_3	8.2	8	7.6	7.8	7.8	7.6	7.6	**7.80a**
T_4	7	7	7.2	7.6	7.8	7.6	7.8	**7.43b**
T_5	7.2	6.6	7.6	7.8	7	7.6	6.8	**7.23bc**
Mean	**7.36a**	**7.04a**	**7.28a**	**7.40a**	**7.24a**	**7.32a**	**7.32a**	

Table:8. Kiwi Fruit Value Addition (Drink) with Non-Nutritive Sweetener in Place of Sugar

	TSS (Brix^{o})							
Treatments	Storage Period (days)							Means
	0	15	30	45	60	75	90	
T7	13.7	13.73	13.83	13.86	13.93	14.07	14.1	13.89a
T8	2.9	2.93	3.13	3.16	3.23	3.23	3.3	3.13b
T9	2.7	2.73	2.96	3.07	3.12	3.12	3.16	2.98c
Means	6.43	6.46	6.64	6.70	6.76	6.81	6.85	
Treatments	**pH**							Means
T7	3.85	3.85	3.83	3.82	3.73	3.66	3.61	3.76a
T8	3.79	3.79	3.74	3.75	3.7	3.64	3.62	3.72b
T9	3.82	3.82	3.79	3.78	3.74	3.72	3.74	3.77a
Means	3.82	3.82	3.79	3.78	3.72	3.67	3.66	
Treatments	**% Acidity**							Means
T7	0.48	0.48	0.48	0.5	0.53	0.57	0.65	0.53c
T8	0.66	0.67	0.68	0.7	0.73	0.76	0.79	0.71b
T9	0.69	0.69	0.7	0.72	0.75	0.76	0.8	0.73a
Means	0.57	0.58	0.58	0.60	0.63	0.67	0.72	
Treatments	**Vitamin C (mg/100ml)**							Means
T7	7.34	7.52	7.09	6.67	6.52	6.32	6.15	6.8b
T8	7.39	7.26	7.09	6.9	6.75	6.62	6.46	6.92b
T9	7.89	7.76	7.63	7.57	7.46	7.3	7.02	7.52a
Means	7.54	7.51	7.27	7.05	6.91	6.75	6.54	
Treatments	**Fe (mg/kg)**	**K (%)**	**Mg (%)**	**Ca (%)**				
T7	322	0.06	0.06	0.14				
T8	237	0.07	0.05	0.15				
T9	320	0.08	0.03	0.14				
kiwi	253	0.34	0.4	0.21				
Means								

Table: 9. Sensory Evaluation of Kiwi Fruit Drink Value Addition with Non-Nutritive Sweetener in Place of Sugar

Color								
Treatment	**Storage Period (days)**							**Means**
	0	**15**	**30**	**45**	**60**	**75**	**90**	
T7	7.2	7.2	6.8	6.5	6.2	6.2	5.8	**5.94c**
T8	7.4	7.3	6.7	6.6	6.4	6.2	5.6	**6.57b**
T9	7.8	7.8	6.8	6.8	7.2	6.8	5.2	**7.20a**
Mean								
Flavor								
T7	6.6	6.6	7	6.8	6.4	7.6	7.6	**6.94b**
T8	6.6	6.6	7	6.8	6.4	7.6	7.6	**6.94b**
T9	8.2	8	7.6	7.8	7	7.8	7.4	**7.69a**
Mean								
Taste								
T7	6.2	6.2	5.6	5.6	5.8	5.6	6	**5.86c**
T8	6.2	6.2	6.4	6.8	6.4	8	7	**6.71b**
T9	8.2	8.2	7.6	7.6	7.8	7.8	8	**7.89a**
Mean								
Overall acceptability								
T7	7.2	6.2	6.4	7.4	6.8	6.4	7.6	**6.86d**
T8	7	7	7.2	7.6	7.8	7.6	7.8	**7.43b**
T9	8.2	8	7.6	7.8	7.8	7.6	7.6	**7.80a**
Mean								

Table: 10. Kiwi Fruit Value Addition (Squash) with Non-Nutritive Sweetener in Place of Sugar

	TSS (Brix^{o})							
Treatments	Storage Period (days)							Means
	0	15	30	45	60	75	90	
T4	50.6	50.63	50.7	50.83	50.89	50.93	51.07	50.81a
T5	6.7	6.73	6.83	6.96	7.06	7.16	7.23	6.95b
T6	6.2	6.23	6.43	6.67	6.93	7.07	7.12	6.66c
Means	21.17	21.20	21.32	21.49	21.63	21.72	21.81	
Treatments	**pH**							Means
T4	2.75	2.75	2.73	2.72	2.7	2.68	2.66	2.71c
T5	2.92	2.92	2.9	2.89	2.82	2.81	2.78	2.86b
T6	2.97	2.97	2.95	2.93	2.92	2.9	2.88	2.93a
Means	2.84	2.84	2.82	2.81	2.76	2.75	2.72	
Treatments	**% Acidity**							Means
T4	1.97	1.97	1.98	2.01	2.06	2.1	2.12	2.03a
T5	1.57	1.57	1.59	1.62	1.63	1.66	1.7	1.62b
T6	1.25	1.25	1.25	1.27	1.3	1.36	1.4	1.3c
Means	1.60	1.60	1.61	1.63	1.66	1.71	1.74	
Treatments	**Vitamin C (mg/100ml)**							Means
T4	3.66	3.63	3.6	3.2	3.16	3.05	2.7	3.29b
T5	3.7	3.6	3.6	3.36	3.2	3	2.66	3.3b
T6	3.86	3.8	3.7	3.4	3.32	3.16	3.05	3.47a
Means	3.68	3.62	3.60	3.28	3.18	3.03	2.68	
Treatments	**Fe (mg/kg)**	**K (%)**	**Mg (%)**	**Ca (%)**				
T4	303	0.14	0.06	0.16				
T5	332	0.2	0.22	0.18				
T6	276	0.24	0.09	0.18				
Means								

Table: 11. Sensory Evaluation of Kiwi Fruit Squash Value Addition with Non-Nutritive Sweetener in Place of Sugar

Color								
Treatment	**Storage Period (days)**							**Means**
	0	**15**	**30**	**45**	**60**	**75**	**90**	
T4	7.8	7.8	7.6	7.4	7.2	7	6.8	**7.37c**
T5	8	8	7.8	7.6	7.4	7.2	7	**7.57bc**
T6	8.6	8.6	8.2	8	7.6	7.4	7.2	**7.94a**
Mean								
Flavor								
T4	7.8	7.8	7.6	7.4	7.2	7	6.8	**7.37c**
T5	8.2	8.2	8	7.8	7.6	7.4	7.2	**7.77b**
T6	8.6	8.4	8.2	8	8	7.8	7.6	**8.08a**
Mean								
Taste								
T4	7.8	7.8	7.6	7.2	7.2	7	6.8	**7.34c**
T5	8	8	7.8	7.6	7.2	7.2	7	**7.54bc**
T6	8.4	8.4	8.2	8	7.8	7.6	7.4	**7.97a**
Mean								
Overall acceptability								
T4	7.8	7.8	7.6	7.4	7.2	6.8	6.6	**7.31c**
T5	8.4	8.2	8	7.8	7.4	7.2	7	**7.71b**
T6	8.6	8.6	8.4	8.2	7.8	7.6	7.4	**8.08a**
Mean								

Table 12: Kiwi Fruit Value Addition (Jam) with Non-Nutritive Sweetener in Place of Sugar

	TSS (Brixo)							
Treatmen	Storage Period (days)							Means
	0	**30**	**60**	**90**	**120**	**150**	**180**	
T1	68.3	68.33	68.5	68.62	69.3	68.93	70.13	68.87a
T2	56.5	56.53	56.73	56.86	57.93	56.96	57.5	57c
T3	60.2	60.26	60.56	60.83	60.73	61.67	62.07	60.9b
Means	61.67	61.71	61.93	62.10	62.65	62.52	63.23	
Treatmen	**pH**							Means
T1	3.14	3.14	3.12	3.04	3.04	2.95	2.9	3.05b
T2	3.29	3.29	3.25	3.16	3.16	3.05	2.95	3.16a
T3	3.05	3.05	3.01	2.9	2.9	2.82	2.75	2.93c
Means	3.16	3.16	3.13	3.03	3.03	2.94	2.87	
Treatmen	**% Acidity**							Means
T1	0.88	0.92	0.92	1.06	1.1	1.13	1.17	1.03a
T2	0.47	0.5	0.5	0.75	0.92	1.1	1.12	0.77b
T3	0.77	0.79	0.79	0.95	1.06	1.12	1.15	0.95a
Means	0.71	0.74	0.74	0.92	1.03	1.12	1.15	
Treatmen	**Vitamin C (mg/100ml)**							Means
T1	7.25	7.06	0.92	6.32	6.15	5.75	5.6	5.58b
T2	9.02	8.76	0.5	7.9	7.35	7	6.75	6.75a
T3	7.95	7.76	0.79	7.4	7.05	6.8	6.32	6.3a
Means	8.07	7.86	0.74	7.21	6.85	6.52	6.22	
Treatmen	**Fe (mg/kg**	**K (%)**	**Mg (%)**	**Ca (%)**				
T1	279	0.05	0.32	0.15				
T2	278	0.08	0.6	0.15				
T3	302	0.11	0.27	0.15				
Means								

Table 13: Sensory Evaluation of Kiwi Fruit Jam Value Addition with Non-Nutritive Sweetener in Place of Sugar

Color								
Treatment	**Storage Period (days)**							**Means**
	0	**30**	**60**	**90**	**120**	**150**	**180**	
T_1	8.2	8.2	8	7.8	7.8	7.6	7.4	**7.85a**
T_2	7.2	7.2	7	6.6	6.6	6.4	6.4	**6.77c**
T_3	7.6	7.6	7.4	7.2	7.2	7	6.8	**7.25b**
Mean								
Flavor								
T_1	7.8	7.8	7.6	7.6	7.4	7.2	7	**7.48a**
T_2	7.2	7.2	7	6.6	6.6	6.4	6.4	**6.77c**
T_3	7.4	7.4	7.2	7	7	6.8	6.6	**7.05b**
Mean								
Taste								
T_1	8.4	8.4	8.2	8	8	7.8	7.8	**8.08a**
T_2	7.8	7.8	7.6	7.4	7.2	7	6.8	**7.37c**
T_3	8	8	7.8	7.8	7.6	7.4	7.2	**7.68b**
Mean								
Overall acceptability								
T_1	8.4	8.4	8.2	8	7.8	7.8	7.6	**8.08a**
T_2	7.8	7.8	7.6	7.4	7.2	7	6.8	**7.37c**
T_3	8	8	7.8	7.6	7.6	7.4	7.2	**7.68b**
Mean								

Table 14. Mean Values for Different Biochemical Parameters of Apple Thyme Jam during Storage

Weeks of Storage	Parameters				
	pH	**Acidity**	**Brix°**	**Vit. C**	**Total Polyphenols**
0	3.57a	0.22e	71.86f	46.54a	41.25a
1	3.56a	0.22e	71.87f	46.38ab	41.07b
2	3.55bc	0.24de	72.03f	46.28ab	40.79c
3	3.53c	0.25c-e	72.27e	46.23a-c	40.49d
4	3.50d	0.25c-e	72.43de	46.22a-c	40.08e
5	3.49de	0.26b-d	72.50d	46.05a-c	39.75f
6	3.48e	0.27b-d	72.58cd	45.90a-c	39.44g
7	3.47ef	0.28bc	72.70bc	45.78a-c	39.17h
8	3.45fg	0.29b	72.76ab	45.61bc	38.81i
9	3.45gh	0.29b	72.82ab	45.41c	38.50j
10	3.43h	0.29b	72.87ab	44.54d	38.22k
11	3.41i	0.34a	72.91a	44.45d	37.90l
12	3.40i	0.35a	72.93a	44.31d	37.50m

Table 15. Mean Values for Organoleptic Evaluation of Apple Thyme Jam during Storage

Weeks of Storage	Parameters			
	Taste	**Flavour**	**Mouth Feel**	**Overall Acceptability**
0	8.00a	8.33a	7.67a	7.99a
1	8.00a	8.33a	7.67a	7.99a
2	8.00a	8.33a	7.67a	7.97a
3	8.00a	8.17a	7.67a	7.94a
4	8.00a	8.00ab	7.17b	7.71b
5	7.75ab	7.70bc	7.17b	7.48c
6	7.65ab	7.50c	7.02c	7.29c
7	7.51bc	7010d	6.70d	7.02d
8	7.12cd	6.95de	6.60e	6.88de
9	7.01d	6.83de	6.48f	6.72ef
10	6.96d	6.77de	6.41fg	6.66f
11	6.91d	6.75de	6.35gh	6.63f
12	6.87d	6.68e	6.33h	6.63f

Table 16. Mean Values for Different Biochemical Parameters of Apple Cinnamon Jam during Storage

Weeks of Storage	Parameters				
	pH	**Acidity**	**Brix°**	**Vit. C**	**Total Polyphenols**
0	3.57a.	0.17f	67.46g	42.70a	72.59a
1	3.57a	0.17f	67.50g	42.62a	72.05b
2	3.55b	0.19e	67.70f	42.55a	71.67c
3	3.52c	0.20e	67.90e	42.42a	71.45f
4	3.49d	0.23d	68.09d	42.24ab	71.06e
5	3.48de	0.24cd	68.13d	42.20ab	70.74f
6	3.47ef	0.24cd	68.54c	42.11a-c	70.46g
7	3.47ef	0.24cd	68.60bc	41.99a-c	69.71h
8	3.47ef	0.25c	68.60bc	41.70a-c	69.48i
9	3.46g	0.25c	68.70ab	41.07bc	69.20j
10	3.42h	0.28b	68.71a	40.94c	68.82k
11	3.41i	0.28b	68.75a	39.71d	68.54l
12	3.39j	0.30a	68.78a	39.61d	68.29m

Table 17. Mean Values for Organoleptic Evaluation of Apple Cinnamon Jam during Storage

Weeks of Storage	Parameters			
	Taste	**Flavour**	**Mouth Feel**	**Overall Acceptability**
0	8.00a	8.33a	8.33a	8.22a
1	8.00a	8.33a	8.00a	8.11a
2	8.00a	8.33a	8.00a	8.10a
3	8.00a	7.83ab	7.67ab	7.83ab
4	8.00a	7.33bc	7.17bc	7.49bc
5	7.67ab	7.33bc	7.00b-d	7.37cd
6	7.67ab	7.33bc	6.73c-e	7.29c-e
7	7.67ab	6.80cd	6.50c-e	7.15c-f
8	7.57ab	6.80cd	6.47c-e	7.06d-g
9	7.50b	6.77cd	6.40c-e	6.94e-g
10	7.42b	6.68cd	6.32de	6.84fg
11	7.36b	6.58d	6.22de	6.79fg
12	7.33b	6.53d	6.18e	6.72g

Table 18. Mean Values for Different Biochemical Parameters of Apple Mint Jam during Storage

Weeks of Storage	Parameters				
	pH	**Acidity**	**Brix°**	**Vit. C**	**Total Polyphenols**
0	3.46a	0.27a	68.50k	42.72a	53.41a
1	3.46a	0.26b	68.54j	42.65a	53.07ab
2	3.45ab	0.25bc	68.61i	42.59a	52.77bc
3	3.45ab	0.24cd	68.64h	42.44ab	52.54c
4	3.44ab	0.23de	68.66h	42.31a-c	52.14d
5	3.43a-c	0.22ef	68.71g	42.30a-c	52.10d
6	3.43a-c	0.21fg	68.73g	42.14a-c	51.65e
7	3.42b-d	0.20gh	68.77f	42.00a-c	51.26f
8	3.40cd	0.20gh	68.87e	41.96a-c	50.98fg
9	3.38d	0.19hi	68.90d	41.24bc	50.75g
10	3.34e	0.19hi	68.93c	41.14c	50.39h
11	3.33e	0.18ij	68.96b	39.68d	50.34h
12	3.31e	0.18ij	68.99a	39.63d	49.82i

Table 19. Mean Values for Organoleptic Evaluation of Apple Mint Jam during Storage

Weeks of Storage	Parameters			
	Taste	**Flavour**	**Mouth Feel**	**Overall Acceptability**
0	8.00a	8.00a	8.00a	8.00a
1	8.00a	8.00a	8.00a	7.99a
2	8.00a	7.67ab	7.97a	7.77b
3	7.75ab	7.25bc	7.67a	7.63b
4	7.50bc	7.25bc	7.33bc	7.35c
5	7.30cd	7.08b-d	7.16cd	7.18cd
6	7.25c-e	6.99c-e	7.05cd	7.09d
7	7.10d-f	6.91c-e	6.97c-e	7.06de
8	7.02d-g	6.83c-e	6.83d-f	6.99d-f
9	6.93e-h	6.75c-e	6.80d-f	6.85e-g
10	6.83f-h	6.68c-e	6.77d-f	6.80fg
11	6.73gh	6.60de	6.53ef	6.70gh
12	6.60h	6.43e	6.40f	6.56h

Table 20. Demographic Frequencies of the Participants			
Demographic Attributes	f	%	
Age (years)			
Less than 25	73	69.52	
25 to 30	28	26.66	
More than 30	4	3.8	
Education			
Secondary	60	57.14	
Higher Secondary	21	20	
Graduation	16	15.23	
Masters	8	7.61	
Marital Status			
Unmarried	88	83.8	
Married	17	16.19	
Family Size			
Less than 5	18	17.14	
5 to 6	34	32.38	
More than 6	53	50.47	
Source of Income (House hold Head)			
Govt. job	13	12.38	
Private job	29	27.81	
Business	54	51.42	
Labourer	9	8.57	
Reason for getting training			
Capacity development	36	34.2	
Free from studies	72	40	
Efficient use of limited Re	7	6.66	
Entrepreneurship	20	19.04	

Table 21. Pre and Post-training Knowledge of the Participants				
Statements	Pre-training		Post-training	
	f	%	f	%
Do you know about methods of food preservation				
Pickling	73	69.52	105	100
Salting	6	5.71	93	88.57
Drying	8	7.62	97	92.38
Freezing	81	77.14	105	100
Canning	0	0	78	74.29
Quartet	46	43.81	98	93.33
What do you know about food safety				
Food free from Bacteria and fungi	42	40	105	100
Food free from heavy metals	13	12.38	105	100
Both of these	41	39.05	105	100
What do you know about balanced diet				
Food contain carbohydrates, proteins and fats	81	77.14	105	100
Food contain essential vitamins	29	27.62	100	95.24
Food contain essential minerals and salts	17	16.19	91	86.67
All of these	89	84.76	91	86.67
What do you know about infection of food		0		0
Appearance of fungi on food	61	58.1	105	100
Food becomes smelly	98	93.33	105	100
Food changes colour	67	63.81	103	98.1
All of these	49	46.67	103	98.1
How food infection could be controlled				
Personal hygiene	33	31.43	101	96.19
Use of clean utensils	56	53.33	103	98.1
Use of clean fruits and vegetables	67	63.81	98	93.33
All of these	29	27.62	93	88.57
What do you know about role of salt in food preservation				
Salt reduces moisture of food	7	6.67	63	60
Salt inhibits microbial growth	9	8.57	54	51.43
All of these	7	6.67	39	37.14
What do you know about role of sugar in food preservation		0		0
Sugar reduces moisture of food	8	7.62	41	39.05
Sugar inhibits microbial growth	9	8.57	37	35.24
All of these	8	7.62	35	33.33
What do you know about food security				
Food security is the condition in which all people,	6	5.71	28	26.67
Balanced food free from bacteria is available	21	20	10	9.52

Table 22. Percentage of Pre and Post-training knowledge of Trainees Regarding Different Food Preparation

Food	Pre-training		Post-training	
	f	%	f	%
Apple jam				
Yes	0	0	91	86.67
No	105	100	14	13.33
Marmalade		0		0
Yes	7	6.67	102	97.14
No	98	93.33	3	2.86
Mango squash		0		0
Yes	11	10.48	105	100
No	94	89.52	0	0
Lemon barley		0		0
Yes	0	0	99	94.29
No	105	100	6	5.71
Mix Pickle		0		0
Yes	17	16.19	95	90.48
No	88	83.81	10	9.52
Strawberry squash		0		0
Yes	0	0	89	84.76
No	105	100	16	15.24

Table 23. Suggestions for Improving future training Programmes			
Suggestions	f	%	Ranks
Emphasis should be given on skill development			
Yes	73	69.52	V
No	32	30.48	
Duration of training must be increased for a week			
Yes	96	91.43	II
No	9	8.57	
Visit to the food-processing unit must be arranged for practical experience			
Yes	81	77.14	IV
No	24	22.86	
Training programme advertisement should be given in the local newspapers/local tv channels			
Yes	95	90.48	III
No	10	9.52	
Marketing aspect of food items should also be covered			
Yes	22	20.95	
No	83	79.05	
Are you satisfied with methodology of training staff			
Yes	105	100	I
No	0	0	
Are you satisfied with behaviour of training staff			
Yes	105	100	I
No	0	0	

BIOCHEMISTRY SECTION

A. RESEARCH WORK

1. NUTRITIONAL COMPARISON OF ADVANCE RICE LINES GROWN IN SALINE-SODIC SOILS USING DIFFERENT LEVELS OF NPK FERTILIZERS

INTRODUCTION

A large area of Pakistan is suffering from salinity problem. Being situated in arid and semiarid region, the process of salinization and sodification remains in progress. Bringing these marginal lands into agriculture production is essential from food security perspectives for rapidly growing population. Rice (*Orzya sativa* L.) is the most important staple food for more than half of the world's population. Rice is being grown in salt effected soil but salt may affect the nutrition and quality of crop. Keeping in view, whether the use of salt effected soil may affect the nutrition of crop, the current experiment was designed to determine the quality of advance rice lines grown in saline-sodic soils.

MATERIALS AND METHODS

Experiment was conducted in collaboration with Soil Salinity Research Institute, Pindi Bhattian. Rice was transplanted in moderately saline-sodic soil having pH 8.65, ECe 5.73 dSm^{-1}, SAR 35.39 mmol/L, available P 8.2 mg/kg, organic matter 0.4% and extractable K 106 mg/kg. Experiment was conducted in split plot design layout. Fertilizer rates were kept in sub plot, while rice advanced lines were kept in main plot. Whole P, K and 1/3 N was applied at the time of rice transplanting, while remaining N was applied in two splits i.e. 25 and 45 days after transplanting. Crop was harvested and paddy samples were collected. Samples were oven dried and ground for determination of crude fat, crude protein, crude fiber and ash contents.

Treatments

A. Rice advanced lines

1 SRI-23

2 SRI-25

B. Fertilizer doses (NPK kg ha^{-1})

1 0-0-0

2 0-86-60

3 75-86-60

4 150-86-60

5	225-86-60
6	150-0-60
7	150-43-60
8	150-129-60
9	150-86-0
10	150-86-30
11	150-86-90

RESULTS AND DISCUSSION

The results regarding the analysis of rice varieties are given in table**.** Application of fertilizer improved the quality parameters including crude protein, crude fat, crude fiber and ash contents significantly. The response of advanced lines towards the fertilizer was found at par. It means that the performance of both lines under saline sodic soil was similar. Results revealed that the best combination of fertilizer was T_5 where NPK was applied @ 225-86-60 kg ha^{-1} for the better quality of rice grown under saline sodic soil. The detail of each quality parameter is as under;

Crude protein:

Fertilizer doses significantly affected the crude protein contents in paddy. Higher percentage of crude protein (9.25%) was found in T_5 where fertilizer dose was 225-86-60 NPK kg ha^{-1} while minimum crude protein (6.93%) was found in T_1 where no fertilizer was applied. Crude protein in other treatments (fertilizer doses) was found between these two values.

Crude fat:

Fertilizer doses significantly affected the crude fat contents in paddy. Higher percentage of crude fat (1.2%) was found T_8 where fertilizer dose was 150-129-60 NPK Kg ha^{-1} while minimum crude fat (0.54%) was found in T1 where no fertilizer was applied. Crude fat in other treatments was observed between these two values.

Crude fiber:

Fertilizer doses significantly affected the crude fiber contents in paddy. Higher percentage of crude fiber (4.37%) was found T_5 where fertilizer dose was 225-86-60 NPK Kg ha^{-1} while minimum crude fiber (2.39%) was found in T1 where no fertilizer was applied. Crude fiber in other treatments was recorded between these two values.

Ash content:

Fertilizer doses significantly affected the ash contents in paddy. Higher percentage of ash

(1.25%) was found T_5 where fertilizer dose was 225-86-60 NPK kg ha^{-1} while minimum ash (0.66%) was found in T1 where no fertilizer was applied. Ash contents in other treatments were found between these two values.

CONCLUSION

Application of fertilizer improved the quality parameters including crude protein, crude fat, crude fiber and ash contents significantly. The response of advanced lines towards the fertilizer was found statistically at par. Results also revealed that the best combination of fertilizer was T_5 where NPK was applied @ 225-86-60 kg ha^{-1} for the better quality of rice grown under saline sodic soil.

Table-1: Effect of NPK fertilizers on crude fat contents of advance lines of rice grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	SRI-23	SRI-25	Mean
	Crude fat (%)	Crude fat (%)	
T_1. 0-0-0	0.58	0.51	0.54 f
T_2. 0-86-60	0.83	0.81	0.82 de
T_3. 75-86-60	0.93	0.91	0.92 cd
T_4. 150-86-60	1.09	1.02	1.06 abc
T_5. 225-86-60	0.93	0.93	0.93 cd
T_6. 150-0-60	0.64	0.77	0.71 ef
T_7. 150-43-60	1.00	0.94	0.97 bcd
T_8. 150-129-60	1.32	1.08	1.20 a
T_9. 150-86-0	0.89	0.83	0.86 de
T_{10}. 150-86-30	1.05	0.96	1.01 bcd
T_{11}. 150-86-90	1.27	1.03	1.15 ab
Mean	0.96	0.89	
LSD	NS	NS	0.1867

Table-2: Effect of NPK fertilizers on crude protein of advance lines of rice grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	SRI-23	SRI-25	Mean
	Crude Protein (%)	Crude Protein (%)	

T_1. 0-0-0	7.19	6.66	6.93 c
T_2. 0-86-60	7.70	7.22	7.46 c
T_3. 75-86-60	7.84	7.41	7.63 c
T_4. 150-86-60	9.07	8.63	8.85 ab
T_5. 225-86-60	9.47	9.03	9.25 a
T_6. 150-0-60	8.75	8.32	8.53 b
T_7. 150-43-60	8.93	8.48	8.70 ab
T_8. 150-129-60	9.38	8.95	9.16 ab
T_9. 150-86-0	8.84	8.40	8.62 ab
T_{10}. 150-86-30	8.96	8.53	8.74 ab
T_{11}. 150-86-90	9.31	8.87	9.09 ab
Mean	8.68	8.23	
LSD	NS	NS	0.7004

Table-3: Effect of NPK fertilizers on crude fiber of advance lines of rice grown in saline-sodic soils

Treatments (NPK Kg ha^{-1})	SRI-23	SRI-25	Mean
	Crude fiber (%)	Crude fiber (%)	
T_1. 0-0-0	2.65	2.12	2.39 g
T_2. 0-86-60	3.19	2.92	3.05 f
T_3. 75-86-60	3.28	3.14	3.21ef
T_4. 150-86-60	3.96	3.81	3.88 bcd
T_5. 225-86-60	4.37	4.37	4.37 a
T_6. 150-0-60	3.36	3.26	3.31 ef
T_7. 150-43-60	3.89	3.38	3.63 cde
T_8. 150-129-60	4.31	4.24	4.28 ab
T_9. 150-86-0	3.77	3.33	3.55 de
T_{10}. 150-86-30	3.95	3.67	3.81 cd
T_{11}. 150-86-90	4.06	4.12	4.09 abc
Mean	3.71	3.49	

LSD	NS	NS	0.4565

Table-4: Effect of NPK fertilizers on ash contents of advance lines of rice grown in saline-sodic soils

Treatments (NPK kg ha^{-1})	SRI-23	SRI-25	Mean
	Ash (%)	Ash (%)	
T_1. 0-0-0	0.58	0.74	0.66 h
T_2. 0-86-60	0.77	0.78	0.78 g
T_3. 75-86-60	0.86	0.83	0.85 fg
T_4. 150-86-60	1.13	1.10	1.12 bc
T_5. 225-86-60	1.27	1.23	1.25 a
T_6. 150-0-60	0.91	0.85	0.88 efg
T_7. 150-43-60	1.02	0.96	0.99 de
T_8. 150-129-60	1.20	1.15	1.18 ab
T_9. 150-86-0	0.94	0.93	0.94 def
T_{10}. 150-86-30	1.09	0.96	1.02 cd
T_{11}. 150-86-90	1.17	1.15	1.17 ab
Mean	1.00	0.97	
LSD	NS	NS	0.1128

2. ASSESSMENT OF ANTIOXIDANT POTENTIAL OF DIFFERENT FRUITS AND VEGETABLES

INTRODUCTION

Antioxidant compounds in food play an important role as a health protecting factor. Scientific evidence suggests that antioxidants reduce the risk for chronic diseases including cancer and heart disease. Fruits and vegetables have higher contents of antioxidants i.e. phenolic and ascorbic acids. Therefore, the present study was planned to determine the antioxidants potential of different fruits and vegetables.

MATERIALS AND METHODS

The present study was conducted at Biochemistry Section, Ayub Agricultural Research Institute, Faisalabad during the year 2019-20 to assess the antioxidants in Fig (*Ficus carica*),

Plum (*Prunus domestica*), cabbage (*Brassica oleracea*) and potato (*Solanum tuberosum*). Fifteen samples of each fruit and vegetable were collected from local market. The fruit samples were analyzed for vitamin-C, pH, TSS, total phenol contents and total antioxidant activity. While vegetable samples were analysed for crude protein, crude fat, crude fiber and ash including antioxidant potential. The pH was measured using pH meter and TSS by using Refracto meter PAL-1. The content of soluble phenols was measured using a modified Folin and Ciocalteu method, employing the reduction of a phospho wolframate–phosphor molybdate complex to blue products by phenolic compounds. The results were expressed as Gallic acid equivalents (GAE), using a calibration curve over the range of 100–300 ppm drawn by using standards of Gallic acid. Antioxidants were determined using the DPPH (1, 1-Diphenyl-2-picrylhydrazyl) method. Juice was added to methanol solution of DPPH and left for 30 minute in dark and record absorbance at 517 nm by using spectrophotometer. DPPH with methanol was run as blank. Percent inhibition was calculated by the equation:

(%DPPH activity) = [(Ao-A)/Ao] x100

Ao = Absorbance of DPPH (0.004%) with Methanol

A = Absorbance of test sample

Protein was determined by kjeldhal method, fat by Soxtec apparatus (ether extraction), Ash was determined by ignition at 600 ^{o}C.

RESULTS AND DISCUSSION

Fruits

Fresh fruit samples were used to prepare pulp and determine the total soluble solids (TSS), pH, total antioxidants, total phenolic contents (TPC) and vitamin C. The results regarding chemical composition of fruits are given in table-5 & 6

Total Soluble Solids (TSS)

Higher percentage of TSS (13.97±0.48%) was observed in fig (*Ficus carica*) as compared to plum (*Prunus domestica*) (12.29 ± 1.32%).

pH:

Significantly higher pH was observed in fig (*Ficus carica*) compared to plum (*Prunus domestica*). The pH (5.31± 0.16) value of fig was significantly higher than plum (3.37 ± 0.21).

Total Antioxidant:

Antioxidant activity (DPPH Scavenging activity) was found higher (88.47 ± 0.55 %) in plum. The lower value of Antioxidant activity (83.98 ± 1.61%) was observed in fig.

Total phenolic contents (TCP):

Significantly higher total phenol contents (551.7 ± 16.88 µg GAE/mL) were found in plum whereas less phenol contents (405 ± 12.2 µg GAE/mL) were found in fig

Vitamin C:

Higher value of vitamin C (8.25 ± 1.12mg/100 g) was observed in plum as compared to fig (2.49 ± 0.45mg/100g)

Vegetables

Vegetable samples were collected from local market. Fifteen samples of each vegetable (potato and cabbage) were collected, oven dried and ground. Crude protein, crude fat, crude fiber and ash contents were determined.

Crude protein:

The crude protein contents in cabbage and potato was found 1.34 ± 0.031% and 1.25±0.082% respectively, higher in cabbage as compared to potato.

Crude fat:

The crude fat contents in cabbage and potato was found 0.11± 0.017% and 0.23±0.023% respectively, higher in potato as compared to cabbage.

Crude fiber:

Crude fiber was higher in cabbage (2.43±0.304%) compared to potato having fiber contents 1.12±0.083%, significantly lower than cabbage.

Ash content:

Ash content was 1.13±0.052% in potato which was significantly higher than cabbage (0.64±0.039%).

CONCLUSION

Analysis of samples revealed that total phenols (571 mg GAE/mL), total antioxidants (89.9% DPPH activity) and vitamin C (10.25 mg/100 mL) were observed higher in plum compared to fig fruit having significantly less total phenols (435.3 mg GAE/mL), antioxidants (87.1% DPPH activity) and vitamin C (3.02 mg/100 mL). Regarding vegetables (On fresh wt basis) higher value of crude fat (0.14%), crude fiber (2.94%), crude protein (1.39%) and ash (0.70%) was observed in cabbage compared to potato having crude fat (0.29%), crude protein (1.43%) ash (1.19%) and crude fiber (1.37%)

Table-5: Chemical analysis of fig and plum

Fruits	TSS (%)	pH	Total antioxidants (% DPPH activity)	Total phenols (µg GAE/mL)	Ascorbic acid (mg/100 ml)
Fig	13.97± 0.48	5.31± 0.16	83.98 ± 1.61	405 ± 12.2	2.49 ± 0.45
Plum	12.29 ± 1.32	3.37 ± 0.21	88.47 ± 0.55	551.7 ± 16.88	8.25 ± 1.12

Table-6: Chemical analysis of potato and cabbage (on fresh weight basis)

Vegetable	Crude fat (%)	Crude fiber (%)	Crude protein (%)	Ash (%)
Potato	0.23±0.023	1.12±0.083	1.25±0.082	1.13±0.052
Cabbage	0.11± 0.017	2.43±0.304	1.34±0.031	0.64±0.039

3. NUTRITIONAL EVALUATION OF MORINGA LEAVE (*Moringa oleifera*) WITH OTHER FODDER CROP

INTRODUCTION

Moringa Oleifera is commonly known as drumstick-tree or horse radish tree. It is used as vegetable and also in Indian folk medicine for the treatment of various illnesses. Leaves of *Moringa oleifera* are a rich source of proteins but contain less carbohydrates and lipids. It contains more ascorbic acid and their leaves are a good dietary source for calcium, magnesium, manganese and copper. Conventionally moringa is used as medicinal purpose and for human consumptions as nutrient source and a rich source of protein with plenty of leaves; it may be used as fodder for animal consumption as a rich source of nutrition for improving the health of animals and milk production as well.

MATERIAL AND METHODS

This experiment was conducted in collaboration with Fodder Research Institute, Sargodha to check the nutritional evaluation of moringa leaves as fodder with other conventional fodders (maize, sorghum, pearl millet, berseem, oat and lucern). This experiment was laid out in CRD design with 15 replications. Samples of Moringa leaves were collected from Biochemistry Section and conventional fodders were collected from Fodder Research Institute, Sargodha. Samples were dried, ground and analyzed for moisture content, ash contents, crude fat, crude fiber, crude protein, antioxidant activity and vitamin C.

RESULT AND DISCUSSION

The results regarding chemical composition of conventional fodders and moringa leaves are given in table-7 and 8

Composition of moringa leaves

Ash content in two different moringa varieties (Pakistan sufaid seed and PK-1 Indian) ranged from 9.40 to 9.60%, moisture content 71.2 to 72.0%, crude protein 27.5 to 27.7%, crude fat 4.56 to 4.82%, crude fiber 11.0%, vitamin C 237.5 to 241.3 mg/100g and antioxidant activity 83.2 to 84.2 % DPPH. Moringa variety (PK-I Indian) performed better due to high ash content (9.60%), crude protein (27.7%), antioxidant DPPH activity (84.3%) and vitamin C (241.3mg/100g). Moringa variety (Pakistan Sufaid Seed) contained high crude fat contents (4.56%)

Composition of various Fodders

Ash content

Ash contents in different fodders ranged from 8.01 to 13.1%. Maximum ash content (13.1%) was found in berseem fodder followed by lucern fodder (10.6%). Moringa leaves contained more ash content (9.50%) as compared to maize fodder (8.35%), sorghum fodder (8.08%), pearl millet fodder (8.41%) and less ash content as compared to berseem fodder (13.1%), lucern fodder (11.5%) and oat fodder (9.65%)

Crude fat

Crude fat contents in different fodders varied from 1.30 to 3.54%. Maximum crude fat (3.54%) was found in Pearl millet fodder followed by berseem fodder (3.40%). Moringa leaves contained more crude fat contents (4.96%) as compared to all other fodders i.e., maize (2.53%), sorghum (2.47%), oat (1.30%), berseem (3.40%), lucern (2.79%) and pearl millet (3.54%)

Crude fiber

Crude fiber contents in different fodders ranged from 20.4 to 28.12 %. Maximum crude fiber content (28.12%) was found in sorghum fodder followed by maize fodder (25.65%). Moringa leaves contained less crude fiber contents (11.0%) as compared to all other fodders i.e., maize (25.65%), sorghum (28.12%), oat (21.7%), berseem (20.4%), lucern (21.9%) and pearl millet (21.34%)

Crude protein

Crude protein contents in various fodders ranged from 7.77 to 20.9%. Maximum crude protein content (20.9%) was found in lucern fodder. Moringa leaves contained more crude

protein contents (27.6%) as compared to all other fodders i.e., maize (13.04%), sorghum (7.77%), oat (10.08%), berseem (17.7%), lucern (20.9%) and pearl millet (9.37%)

CONCLUSION

It is concluded that moringa leaves contained more crude protein (17.6%) and crude fat (4.96%) as compared to other conventional fodder. While vitamin C (239.4 mg/100g) and antioxidant activity (83.7% DPPH) are additional benefits to animals if grazed on moringa leaves with conventional fodders.

Table-7: Chemical composition of moringa leaves

Moringa varieties	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)	Vitamin C (mg/100g)	Antioxidant DPPH activities (%)	Moisture (%)
Pakistan Sufaid Seed	9.40	4.82 a	11.0	27.5	237.5	83.2	71.19 b
PK-1 Indian	9.60	4.56 b	11.0	27.7	241.3	84.2	72.08 a
LSD	NS	0.11	NS	NS	NS	NS	0.25

Table-8: Chemical composition of conventional fodders

Fodders	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
Maize	8.35 a	2.53 c	25.65 b	13.04 c
Sorghum	8.08 d	2.47 c	28.12 a	7.76 f
Pearl millet	8.41 d	3.54 a	21.34 cd	9.37 e
Oat	9.65 c	1.30 d	21.7 c	10.08 d
Berseem	13.1 a	3.40 a	20.4 b	17.7 b
Lucern	11.5 b	2.79 b	21.9 c	20.9 a
LSD	0.27	0.11	0.50	0.24

4. QUALITY COMPARISON OF CARROT AND SWEET PEA GROWN IN SPECIFIC AREAS WITH THOSE GROWN IN SCATTERED AREAS OF FAISALABAD DISTRICT

INTRODUCTION

Vegetables are the fresh and edible portions of herbaceous plants. They are useful component of our daily diet and are source of various minerals and vitamins. Dietary fiber from vegetables helps to reduce blood cholesterol levels and may lower risk of heart disease. Although carrot is grown in different villages of Faisalabad but the vegetables (carrot and sweet

peas) grown in clusters like Manawala, Shahkot are considered more nutritious than those grown in scattered areas (Areas other than cluster for carrot and peas). The climate conditions may affect the nutritional composition of vegetables grown in different areas and soil conditions also. So it is imperative to assess the nutritional quality of vegetables, grown in clusters as well as in scattered areas.

MATERIALS AND METHODS

This experiment was conducted at Biochemistry Section Ayub Agricultural Research Institute, Faisalabad. Thirty samples, each of carrot and peas, from ten villages of cluster areas and ten villages of scattered areas were collected. Vegetables (Carrot and sweet peas) were collected from farmer fields of cluster areas (Shahkot) and scattered areas (Villages of Faisalabad) during growing season (February, March) of carrot and sweet peas. Fresh weight of vegetables were noted and samples were oven dried, weighed for dry matter and ground for determination of crude fat, crude protein, crude fiber and mineral matter.

Vegetables	Area 1	Area 2
Carrot & sweet pea	Villages of Shahkot (Chak No. 82 RB, Chak No. 80 RB, Chak No. 79 RB, Chak No.81 RB, Chak No. 18 RB, Chak No. 78 RB, Chak No. 83 RB, Chak No. 10RB, Chak No. 17 Safdarabad)	Villages of Tehsil Faisalabad (Chak No. 206 RB, Chak No. 194 RB, Chak No. 37 JB, Chak No.63 JB, Chak No. 33 JB, Chak No. 34 JB, Chak No. 36 JB (big), Chak No. 36 JB (small), Chak No. 34 JB, Chak No. 62 JB)

RESULTS AND DISCUSSION

The results regarding nutritional quality parameters of vegetables are given in table-9

Crude protein:

No significant difference was found in crude protein contents of the carrot, collected from hub areas and scattered areas. However there was a small difference in crude protein of carrot, sampled from hub and scattered areas. Crude protein was 0.93% ±0.028 in carrot sampled from scattered areas compared to 1.04% ± 0.032 in carrot of Hub areas. In case of sweet peas sampled from Farmers field of Tehsil Faisalabad (Scattered areas), protein content were 4.43% ±0.073 as compared to 4.97% ± 0.245 in sweet peas, sampled from Hub areas

Crude fat:

No significant difference was found in crude fat contents of the carrot, collected from hub areas and scattered areas. However there was a small difference in crude fat of carrot, sampled from hub area than that collected from scattered area. Crude fat was 0.42% ± 0.016 in

carrots sampled from scattered areas and it was 0.45% ± 0.019 in carrot, sampled from Hub areas. In case of sweet peas sampled from scattered areas, the fat content was 0.42%±0.014 as compared to 0.39% ± 0.053 sampled from Hub areas.

Crude fiber:

No significant difference was found in crude fiber contents of the carrot, collected from hub areas and scattered areas. Crude fiber of carrot was 3.93% ± 0.404 in samples, collected from scattered areas compared to 4.27% ± 0.155 of Hub areas. In case of sweet peas, crude fiber was slightly higher 3.43% ± 0.189 in samples collected from scattered areas as compared to those, collected from hub areas (3.59% ± 0.233).

Ash content:

No significant difference was found in ash contents of the carrot, collected from hub areas and scattered areas. However on average, ash content in carrot was 1.15±0.039 in samples, collected from scattered areas compared to 1.22 ± 0.034 in samples of Hub areas. In case of sweet peas ash contents were 0.54±0.014 in samples of scattered area compared to 0.52±0.023 of Hub areas.

CONCLUSION

Samples of carrot and sweat peas were collected from various villages of hub (Shahkot) and Scattered areas of Faisalabad. Proximate analysis showed that there was no significant difference in biochemical composition of carrot and sweet peas, collected from Hub (Shahkot) as well as from scattered area.

Table-9: Proximate analysis of carrot and sweet peas sampled from Hub and scattered areas of Faisalabad

Parameters	Carrot (Fresh wt basis)		Sweet peas (Fresh wt basis)	
	Hub Area	Scattered area	Hub Area	Scattered area
Crude protein (%)	1.04 ± 0.032	0.93±0.028	4.97±0.245	4.43±0.073
Crude fat (%)	0.45 ± 0.019	0.42± 0.016	0.39 ± 0.053	0.42±0.014
Crude fiber (%)	4.27±0.155	3.93 ±0.404	3.59± 0.233	3.43±0.189
Ash (%)	1.22±0.034	1.15±0.039	0.52±0.023	0.54±0.014

Number of samples (n) =15

5. NUTRITIONAL QUALITY EVALUATION OF DIFFERENT GRAPES VARIETIES

INTRODUCTION

Grapes are small round or oval berries that feature semi-translucent flesh encased by a smooth skin. Some contain edible seeds while others are seedless. Grapes are an excellent source of vitamin C, total phenols and tartaric acid. Grapes are a rich source of minerals including copper, iron and manganese. In past, the grapes were grown only in Balochistan and KPK as commercial crop. Presently, farmers of Punjab have started growing of grapes. Present study was designed to evaluate the nutritional quality of different grapes varieties grown in Punjab.

MATERIALS AND METHODS

This experiment was conducted in collaboration with Barani Agriculture Research Institute, Chakwal. Nine varieties of grapes i.e., Kings Ruby, Flame seedless, Vitro black, Sultanina-C, Priest, Superior, Chasslas, Muscat and Danlas were collected from Barani Agriculture Research Institute, Chakwal during the month of July 2019. Samples of each variety were analyzed for ascorbic acid (Vitamin C), tartaric acid, TSS, sugars, acidity, copper, manganese and iron.

RESULT AND DISCUSSION

The results regarding chemical composition of grape varieties are given in table-10 & 11

Total soluble solids (TSS):

TSS of fresh grapes samples ranged from 10.6 to 19.9 %. Maximum TSS (19.9 %) was recorded in variety Vitro Black while minimum TSS (10.6 %) was recorded in variety Danlas.

Tartaric acid:

Tartaric acid of different grapes varieties ranged from 0.29 to 0.61 %. Maximum tartaric acid (0.61%) was recorded in variety Priest and minimum (0.29%) was present in variety Vitro Black.

Vitamin-C:

Among all the nine grapes varieties, vitamin C was higher (4.55 mg/100 g) in variety Chasslas followed by Sultanina C (4.41mg/100g) whereas, lower value (3.34 mg/100g) was observed in variety Vitro Black.

Reducing sugar:

Data regarding the reducing sugar of juice ranged from 7.58 to 13.65 %. Maximum reducing sugar (13.65%) was recorded in variety Sultanina C while minimum reducing sugar (7.58%) was recorded in variety Flame Seedless.

Total invert sugar:

Total invert sugar recorded in grapes juice ranged from 12.3 to 19.8 %. Maximum total invert sugar (19.8%) was observed in variety Sultanina C while minimum total invert sugar (12.3%) was recorded in variety Danlas.

Non reducing sugar:

Non reducing sugar of grapes juice ranged from 1.41 to 8.46 %. Maximum non reducing sugar (8.46%) was recorded in variety Superior while minimum non reducing sugar (1.41 %) was observed in variety Kings Ruby.

Copper (Cu):

Copper content of grapes (on dry weight basis) ranged from 6.68 to 16.22 mg/kg. Maximum Copper content (16.22 mg/kg) was recorded in variety Sultanina C while minimum Copper content (6.68 mg/kg) was recorded in variety Danlas.

Iron (Fe):

Iron content of grapes samples (on dry weight basis) ranged from 66.2 to 117.1 mg/kg. Maximum Iron content (117.1 mg/kg) was recorded in variety Flame Seedless while minimum Iron content (66.2 mg/kg) was recorded in variety Muscat.

Manganese (Mn):

Manganese content of grapes samples (on dry weight basis) ranged from 10.1 to 26.2 mg/kg. Maximum manganese content (26.2 mg/kg) was recorded in variety Kings Ruby while minimum Iron content (10.1 mg/kg) was recorded in variety Danlas.

Acidity:

Acidity of fresh grapes juice ranged from 0.42 to 0.85 %. Maximum acidity (0.85%) was observed in variety Priest while minimum acidity (0.42 %) was recorded in variety Kings Ruby.

CONCLUSION

It is concluded that higher reducing sugar (13.65%), total sugar (19.8%), vitamin C (4.41 mg/100g) and copper (16.22 mg/kg) was found in variety Sultanina C while higher acidity (0.85%) and tartaric acid (0.61%) was found in variety Priest. On quality parameter basis, variety Sultanina C was comparatively found better than other varieties due to its high sugar, vitamin C and copper contents.

Table-10: Nutritional composition of different grapes varieties

Variety	TSS (%)	Tartaric acid (%)	Reducing sugar (%)	Total sugar (%)	Non reducing sugar (%)	Acidity (%)	Vitamin C (mg/100g)
Sultanina C	14.5 c	0.50 b	13.65 a	19.8 a	5.87 c	0.75 b	4.41 a
Danlas	10.6 g	0.34 d	9.05 d	12.8 c	3.56 e	0.52 e	3.56 c
Priest	11.7 f	0.61 a	7.58 f	12.3 c	4.44 d	0.85 a	3.86 b
Flame Seedless	12.4 e	0.40 c	7.65 f	12.5 c	4.61 d	0.57 d	3.53 c
Muscat	13.8 d	0.49 b	8.24 e	15.3 b	6.69 b	0.69 c	4.09 b
Superior	11.1 g	0.43 c	10.28 c	19.2 a	8.46 a	0.60 d	3.38 c
Kings Ruby	15.3 b	0.33 de	11.42 b	12.9 c	1.41 f	0.42 f	4.04 a
Vitro black	19.9 a	0.29 e	8.73 d	12.6 c	3.66 e	0.45 f	3.34 c
Chasslas	14.2 cd	0.43 c	11.17 b	15.4 b	4.04 de	0.61 d	4.55 a
LSD	0.28	0.03	0.21	0.33	0.37	0.02	0.14

Table-11: Nutritional composition of different grapes varieties

Variety	Mn (mg/kg)	Cu (mg/kg)	Fe (mg/kg)
Sultanina C	15.6 d	16.22 a	79.5e
Danlas	10.1 h	6.68 g	75.9 f
Priest	15.9 d	13.35 c	85.1 d
Flame Seedless	21.5 b	11.33 d	117.1 a
Muscat	14.0 e	11.92 d	66.2 g
Superior	12.8 f	8.47 f	115.7 a
Kings Ruby	26.2 a	14.90 b	99.4 b
Vitro black	19.6 c	16.00 a	78.6 e
Chasslas	11.9 g	9.16 e	96.9 c
LSD	0.34	0.29	0.88

6. COOKING EFFECT ON NUTRITIONAL QUALITY OF VARIOUS VEGETABLES

INTRODUCTION

Vegetables are an important part of the human diet and a major source of biologically active substances and minerals. In Pakistan, people are used to use vegetables after cooking which may cause loss in nutrition of vegetables. The experiment is designed to observe the effect of cooking and cooking duration on the loss of nutrients in vegetables.

MATERIALS AND METHODS

This study was conducted at Biochemistry Section, AARI, Faisalabad on four winter vegetables to check the effect of cooking and cooking period on carrot (*Daucus carota*), pea (*Pisum sativa*), turnip (*Brassica rapa*) and cauliflower (*Brassica oleracea*). Different treatments Raw (no cooking), 20 minutes cooking (Boiling at 100°C), 40 minutes cooking (Boiling at 100°C) and Indian cooking (Home cook) i.e., cooking with spices for a period of more than one hour were applied to the vegetables and analyzed for crude protein, crude fiber, crude fat and ash on dry weight basis.

RESULT AND DISCUSSION

The results regarding chemical composition of raw and cooked vegetables are given in table-12.

Carrot:

Results revealed that cooking had no significant effect on quality parameters ash, crude fat and crude fiber except crude protein. Crude protein decreased from 6.59% (raw) to 3.09% by cooking with spices for the period of more than one hour. Ash content in carrot ranged from 5.02 to 6.30%, crude protein 3.09 to 6.59%, crude fat 1.83 to 2.28% and crude fiber 6.42 to 7.01%.

Pea:

Results revealed that cooking had no significant effect on quality parameters ash, crude fat and crude fiber except crude protein. Crude protein decreased from 13.07% (raw) to 5.05% by cooking with spices for the period of more than one hour. Ash content in pea ranged from 2.34 to 2.67%, crude fat 1.31 to 1.48% and crude fiber 9.53 to 9.64%.

Turnip:

Results revealed that cooking had no significant effect on quality parameters ash, crude fat and crude fiber except crude protein. Crude protein decreased from 8.52% (raw) to 2.42% by cooking with spices for the period of more than one hour. Turnip has ash content ranged from 6.29 to 7.55%, crude fat 1.14 to 1.24%, and crude fiber 10.6 to 11.6%.

Cauliflower:

Results revealed that cooking had no significant effect on quality parameters ash, crude fat and crude fiber except crude protein. Crude protein decreased from 15.10% (raw) to 5.22% by cooking with spices for the period of more than one hour. Ash content in cauliflower ranged from 6.31 to 7.32%, crude fat 2.02 to 2.14% and crude fiber 9.72 to 10.22%.

CONCLUSIONS

It is concluded that cooking had no effect on ash content, crude fat and crude fiber while the value of crude protein decreased with increasing boiling time in all four vegetables. Decrease in crude protein by boiling was observed in carrot up to 47%, in pea 39%, in turnip 28% and in cauliflower 35%.

Table-12: Proximate nutritional composition of different vegetables affected by different cooking period

Vegetables	Cooking period	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
Carrot	No cooking (Raw vegetables)	5.02	1.83	6.89	6.59
	20 min cooking	6.30	2.08	7.01	6.36
	40 min cooking	6.23	2.04	6.67	5.86
	Indian cooking	6.15	2.28	6.42	3.09
Pea	No cooking (Raw vegetables)	2.67	1.48	9.64	13.07
	20 min cooking	2.55	1.31	9.65	12.00
	40 min cooking	2.34	1.31	9.53	10.63
	Indian cooking	2.61	1.33	9.55	5.05
Turnip	No cooking (Raw vegetables)	6.35	1.22	10.60	8.52
	20 min cooking	7.55	1.14	11.07	8.17
	40 min cooking	6.61	1.24	11.60	6.45
	Indian cooking	6.29	1.19	10.70	2.42
Cauliflower	No cooking (Raw vegetables)	7.32	2.14	9.73	15.10
	20 min cooking	6.55	2.02	10.04	13.60
	40 min cooking	6.61	2.09	9.95	11.13
	Indian cooking	6.31	2.10	10.22	5.22

7. EFFECT OF PHOSPHORUS APPLICATION ON NUTRITIONAL QUALITY AND YIELD OF WHEAT

INTRODUCTION

Wheat (*Tritium aestivum* L.) is an important food crop of Pakistan. It cultivated on the largest acreages in almost every part of the country and being used as a staple food by the people. It is a principal source of nutrition for human beings. There are a number of reasons for low yield of wheat in Pakistan. One of the reasons is the application of imbalanced fertilizer. A large number of farmers use less quantity of phosphorus than recommended dose which may affect the yield as well as quality of produce. Present study was planned to evaluate the Impact of phosphorus application along with N & K on yield and quality of wheat grain.

MATERIALS AND METHODS

A field experiment was conducted at field area of Biochemistry Section AARI, Faisalabad. Wheat variety Anaj 2017 was sown with RCBD design and three replications. The treatment plan is as under;

Treatments	**Fertilizer dose (kg ha^{-1})**
T_1	NK (120-70)
T_2	NK (120-70) + P (60)
T_3	NK (120-70) + P (80)
T_4	NK(120-70) + P (100)
T_5	NK (120-70) + P (120)

Full dose of potassium (SOP) and phosphorus (DAP) were applied at the time of sowing while nitrogen in two splits. All necessary agronomic practices were followed during the course of study. At the time of harvesting, yield data were recorded. Representative grain samples were collected from each treatment, thrashed, dried, ground and analyzed for its nutritional quality. The data obtained was analyzed statistically.

RESULTS AND DISCUSSION

The results of yield and chemical composition of wheat grain are given in table-13 and 14

Grain yield:

The application of phosphorus increased the grain yield significantly over the control. The grain yield ranged from 3.13 to 4.31 t ha^{-1}. Maximum grain yield (4.31 t ha^{-1}) was obtained

with T_5 where Phosphorus was applied @ 120 kg ha^{-1} while minimum grain yield (3.13 t ha^{-1}) was recorded in T_1 (control) where no Phosphorus was applied.

Dry matter:

Phosphorus application did not affect the dry matter content of wheat grain which ranged from 82.7 to 87.8 %.

Ash content:

Application of phosphorus @ 120 kg ha^{-1} increased the ash contents of wheat grain which ranged from 0.95 to 1.13 %. Maximum ash content (1.13 %) was obtained with T_5 where Phosphorus was applied @ 120 kg ha^{-1}. Minimum ash content (0.95 %) was found in T_3 where Phosphorus was applied @ 80 kg ha^{-1}.

Crude fat:

Similarly crude fat contents were also significantly affected by the application of P. Crude fat contents of grain ranged from 1.04 to 1.16 %. Maximum crude fat was observed in T_5 (1.16 %) where Phosphorus was applied @ 120 kg ha^{-1}. Minimum crude fat (1.04 %) was analyzed in T_1 (control).

Crude protein:

The analysis result of wheat showed that crude protein contents were also increased which ranged from 9.86 to 10.15 %. Maximum crude protein content (10.15 %) was found in T_5 where 120 kgha^{-1} P was applied. Minimum crude protein content (9.86 %) was analyzed in T_1 (control).

Crude fiber:

Phosphorus applied @ 120 kg ha^{-1} gave the highest crude fiber as compared to other treatments. Crude fiber content in wheat grain varied from 0.98 to 1.00 %. Maximum crude fiber content (1.00 %) was observed in T_5 and minimum (0.98 %) crude fiber content was found in control.

CONCLUSION

Phosphorus application @ 120 kg ha^{-1} along with recommended dose of NK increased the grain yield and improved the nutritional quality of wheat grain. Phosphorus application @ 120 kg ha^{-1} along with recommended dose of NK produced maximum grain yield (4.31 t ha^{-1}), ash (1.13 %), crude fat (1.16 %), crude fiber (1.0%) and crude protein (10.15 %).

Table-13: Effect of Phosphorus application on the yield and nutritional quality of wheat grain

Treatments (kg ha^{-1})	Grain yield (t ha^{-1})	Dry matter (%)
NK (120-70)	3.13 d	82.7 c
NK (120-70) + P (60)	3.46 c	84.5 bc
NK (120-70) + P (80)	3.90 b	83.4 bc
NK(120-70) + P (100)	4.10 ab	85.2 b
NK (120-70) + P (120)	4.31 a	87.8 a
LSD	0.12	1.05

Table-14: Effect of Phosphorus application on the yield and nutritional quality of wheat grain

Treatments (kgha^{-1})	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)
NK (120-70)	1.01 b	1.04 b	9.86	0.98 b
NK (120-70) + P (60)	1.06 ab	1.10 ab	9.92	1.05 a ab
NK (120-70) + P (80)	0.96 b	1.11 a	10.03	0.99 ab
NK(120-70) + P (100)	1.11 a	1.13 a	10.09	1.04 ab
NK (120-70) + P (120)	1.13 a	1.16 a	10.15	1.00 ab
LSD	0.05	0.03	NS	0.03

8. NUTRITIONAL QUALITY EVALUATION OF VARIOUS VARIETIES / LINES OF KHARIF FODDERS

INTRODUCTION

Kharif fodders are sown in summer and harvested in late summer or during the rainy season. Some of the kharif fodders are maize, pearl millet, linseed, blackgram and cowpea etc. Fodder production during kharif is very important to feed animals. It contains sufficient quantity of nutrition like protein, fiber and minerals. Fodders quality is very important for sustainable milk production and animal health as well. Maize, sorghum and pearl millet are commonly grown as kharif fodders in Punjab. The study was therefore planned to evaluate the nutritional quality of varieties/lines of these commonly grown fodders.

MATERIAL AND METHODS

Sample of varieties/lines of maize, sorghum and pearl millet fodder were collected from fodder research Institute Sargodha during August and September. After that samples were dried, ground and analyzed for dry matter, ash contents, crude fat, crude fiber and crude protein.

RESULT AND DISCUSSION

Maize fodder

Results are given in table-15

Ash content:

Ash contents ranged from 7.58 to 9.55%. Maximum ash content (9.55%) was found in the line MS 0416 of maize fodder. Minimum ash content (7.58%) was found in the line No 15345 of maize fodder.

Crude fat:

Crude fat contents varied from 2.08 to 3.27%. Maximum crude fat content (3.27%) was found in the line MS 0416 of maize fodder. Minimum crude fat (2.08%) was found in the variety MMRI yellow of maize fodder.

Crude fiber:

Crude fiber contents varied from 23.0 to 27.7%. Maximum crude fiber content (27.7%) was found in the variety SGD 2002 of maize fodder. Minimum crude fiber (23.0%) was found in the variety Mycon of maize fodder.

Crude protein:

Crude protein contents varied from 10.1 to 14.0%. Maximum crude protein content (14.0%) was found in the variety SGD 2002 of maize fodder. Minimum crude protein (10.1%) was found in the line A of maize fodder.

CONCLUSION

It is concluded that crude fat (3.27%) and ash % (9.55%) were found higher in the line MS 0416 while crude protein (14.0%) and crude fiber (27.7) were found higher in the variety SGD 2002 of maize fodder.

Table-15: Proximate nutritional composition of various varieties/lines of maize fodder

Varieties/Lines	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
No. 15345	7.58 e	2.61 bc	27.8 a	13.2 cd
My con	8.54 c	2.52 bc	23.0 c	11.6 fgh
Malka	8.32 cd	2.57 bc	23.5 bc	12.2 ef
Sgd 2002	9.12 b	2.37 cd	27.7 a	14.0 a

Super green	8.29 cd	2.38 cd	25.8 abc	11.0 h
MMRI yellow	8.97 b	2.08 d	23.5 bc	13.7 abc
Pearl maize	9.16 b	2.88 ab	26.3 ab	12.2 ef
Pearl NPK	7.60 e	2.88 ab	23.7 bc	13.2 bcd
No. 19189	8.14 d	2.58 bc	23.6 bc	14.0 ab
P 3939	7.72 e	2.66 bc	23.2 bc	11.9 fg
MS 04 16	9.55 a	3.27 a	25.1 abc	13.6 abcd
No. 15262	7.76 e	2.49 bc	23.7 bc	11.4gh
YH 1898	8.25 d	2.68 bc	26.3 ab	12.8de
A	7.67 e	2.42 cd	25.5 abc	10.1 i
B	7.65 e	2.38 cd	24.1 bc	12.3 ef
LSD	0.13	0.19	1.55	0.39

Sorghum fodder

Results are given in table-16

Ash content:

Ash contents ranged from 7.21 to 9.60%. Maximum ash content (9.60%) was found in the line V6 of sorghum fodder. Minimum ash content (7.21%) was found in the line V1 of sorghum fodder.

Crude fat:

Crude fat contents varied from 2.14 to 2.93%. Maximum crude fat content (2.93%) was found in the line V2 of sorghum fodder. Minimum crude fat (2.14%) was found in the line V5 of sorghum fodder.

Crude fiber:

Crude fiber content ranged from 25.5 to 31.4%. Maximum crude fiber content (31.4%) was found in the line V5 of sorghum fodder. Minimum crude fiber (25.5%) was found in the line V2 of sorghum fodder.

Crude protein:

Crude protein contents differed from 11.6 to 13.8%. Maximum crude protein content (13.8%) was found in the line V6 and V4 of sorghum fodder. Minimum crude protein (11.6%) was found in the variety SGD 013- 1 of sorghum fodder.

CONCLUSION

It is concluded that crude fiber (31.4%) was found higher in the line V5 while crude protein (13.8 %) was found more in the line V4 andV6 of sorghum fodder.

Table-16: Proximate nutritional composition of various varieties/lines of sorghum fodder

S. No.	Varieties / Lines	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude Protein (%)
1.	V1	7.21 g	2.55 cde	25.8 ef	11.9 bc
2.	V2	8.11 f	2.93 a	25.5 f	12.2 ab
3.	V3	9.03 bcd	2.39 de	28.9 b	13.5 cd
4.	V4	7.43 g	2.45 cde	31.4 a	13.8 efg
5.	V5	7.61 g	2.14f	31.4 a	13.7 g
6.	V6	9.60 a	2.32 ef	29.5 b	13.8 fg
7.	V7	8.77 cd	2.61 cd	27.3 cde	12.9 ab
8.	V8	8.62 de	2.89 ab	26.6 def	12.7 def
9.	FRI-07	9.50 a	2.89 ab	28.4 bc	13.6 a
10.	Sgd-013 1	8.25 ef	2.90 a	23.7 g	11.6 def
11.	Sgd-013 2	9.18 abc	2.59cd	23.0 g	11.6 a
12.	Sorghum 2011	9.24 ab	2.66 bc	28.1 bcd	13.3 de
LSD		0.22	0.11	0.77	0.17

Pearl millet fodder

Results are given in table-17

Ash content:

Ash contents ranged from 6.40 to 9.40%. Maximum ash content (9.40%) was found in the line P6 of pearl millet. Minimum ash content (6.40%) was found in the line P8 of pearl millet fodder.

Crude fat:

Crude fat contents varied from 3.23 to 3.95%. Maximum crude fat content (3.95%) was found in the line P4 of pearl millet fodder. Minimum crude fat (3.23%) was found in the variety Composite IV of pearl millet fodder.

Crude fiber:

Crude fiber contents ranged from 18.9 to 23.0%. Maximum crude fiber content (23.0%) was found in the variety Q Bajra of pearl millet. Minimum crude fiber (18.9%) was found in the line P1 of pearl millet fodder.

Crude protein:

Crude protein contents differed from 9.01 to 10.19%. Maximum crude protein content (10.19%) was found in the variety G Bajra of pearl millet. Minimum crude protein (9.01%) was found in the line P10 of pearl millet fodder.

CONCLUSIONS

It is concluded that ash (9.40%) and crude fat (3.95%) were found higher in the line P6 and P4 while crude protein (10.19%) and crude fiber (23.0%) were found higher in the variety G Bajra and Q Bajra of pearl millet variety as compared to other varieties.

Table-17: Proximate nutritional composition of various varieties/lines of pearl millet fodder

S. No.	Varieties/Lines	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1.	Composite IV	7.49 e	3.23 d	21.3 bcd	9.22 d
2.	Q bajra	7.50 e	3.77 abc	23.0 a	9.36 cd
3.	G bajra	7.40 e	3.58 abcd	21.1 cd	10.19 a
4.	SGD 2011	8.35 cd	3.30 cd	22.8 ab	9.51 bcd
5.	P1	7.71 e	3.49 abcd	18.9 e	9.45 bcd
6.	P2	8.46 bc	3.45 bcd	20.9 cd	9.97 abc
7.	P3	7.54 e	3.53 abcd	22.0 abc	9.42 bcd
8.	P4	7.86 de	3.95 a	20.1 de	9.42 bcd
9.	P5	8.90ab	3.82 ab	20.2 de	9.02d
10.	P6	9.40 a	3.54 abcd	22.3 abc	8.90 d
11	P7	7.72 e	3.37 bcd	20.2 de	9.51 bcd
12	P8	6.40 f	3.42 bcd	20.2 de	10.06 ab
13	P9	8.57 bc	3.34bcd	21.3bcd	10.07 ab
14	P10	6.65f	3.25d	22.2abc	9.01 d
15	P11	6.51 f	3.66 abcd	21.0 cd	9.33 cd
LSD		0.24	0.23	0.81	0.32

9. NUTRITIONAL COMPARISON OF QUINOA FLOUR (*Chenopodium quinoe* Willd.) WITH OTHER CEREALS

INTRODUCTION

Quinoa belongs to family *Cheno podiaceae* and is related to well-known agricultural crops such as sugar beet (*Beta vulgaris*) and spinach (*Spinacia oleracea*). It has high concentration of protein and minerals. Quinoa contains more phenols than other cereals. Quinoa is considered as a multipurpose agricultural crop because its seeds may be utilized for human

food and in flour products because of its high nutritive value. It is cooked as rice and is used to make bread, soups, biscuits and drinks. It has potential to be grown as food, feed or as an oil seed crop. Therefore, this study was planned to compare the nutritional quality of quinoa flour with other cereals (rice, maize, wheat and barley).

MATERIAL AND METHODS

This experiment was conducted at Biochemistry Section, AARI, Faisalabad to study the nutritional comparison of quinoa flour with other cereals (wheat, rice, corn and barley). This experiment was laid out in CRD with ten replications. Samples were dried, ground and analyzed for Moisture content, ash contents, crude fat, crude fiber and crude protein.

RESULT AND DISCUSSION

Results are given in table-18

Moisture:

Moisture contents in different cereal flours ranged from 7.88 to 9.7 %. Maximum moisture (9.7%) was found in Wheat flour. Minimum moisture content (7.88%) was found in Barley flour. Moisture content of Quinoa was 9.07 %.

Ash content

Ash contents ranged from 1.10 to 2.47%. Maximum ash content (2.47%) was found in Quinoa (UAF S21) flour while minimum ash content (1.11%) was found in Wheat flour. Two to three times more ash contents were found in Quinoa flour as compared to wheat flour which had 1.11% ash contents

Crude fat

Crude fat contents varied from 1.17 to 4.27% in various cereal grains. Maximum crude fat content (4.27%) was found in Quinoa (UAF S21) flour. Minimum crude fat (1.17%) was found in wheat flour. Quinoa had three times more crude fat as compared to wheat.

Crude fiber

Crude fiber contents in different cereals flour ranged from 0.98 to 4.16 %. Maximum crude fiber content (4.16%) was found in Quinoa (UAF S46) flour. Minimum crude fiber (0.98%) was found in wheat flour. Quinoa had three times more crude fiber as compared to wheat.

Crude protein

Crude protein contents ranged from 10.6 to 12.5% in various cereal grains. Maximum crude protein content (12.5%) was found in Barley and minimum crude protein (10.6%) was

present in wheat flour. Crude protein content in wheat was 10.6% which was at par with quinoa flour (11.0%)

CONCLUSION

It is concluded that ash content (2.47%), crude fat (4.27%) and crude fiber (4.16%) was found higher in the Quinoa flour as compared to wheat flour which contained ash content (1.11%), crude fat (1.17%) and crude fiber (0.98%) while crude protein in Quinoa flour (11.0%) was at par with wheat flour (10.6%).

Table-18: Chemical composition of Quinoa and other cereals flours

S. No.	Cereals	Moisture (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1.	Quinoa UAF S21	9.24 ab	2.47 a	4.27 a	4.14 a	10.8 b
2.	Quinoa SAF S16	9.12 b	2.45 a	4.16 a	4.11 a	11.0 b
3.	Quinoa UAF S46	8.86 b	2.45 a	4.18 a	4.16 a	11.0 b
4.	Wheat	9.70 a	1.11 b	1.17 c	0.98b	10.6 b
5.	Barley	7.88 c	2.31 a	1.45 b	4.08 a	12.5 a
6.	LSD	0.26	0.11	0.07	0.06	0.26

10. EVALUATION OF NUTRITIONAL STATUS OF DIFFERENT RABI AND KHARIF FODDERES

INTRODUCTION

Fodder crops are the main and nutritive source of feed for livestock. Various fodders vary in nutrition. The awareness regarding the nutrition of fodders is very important to manage the daily ration for livestock. Balanced nutrition is important for animals for ample meat and milk production. Present study was designed to evaluate nutritional status of different Rabi and Kharif fodders for the better management of feeding program for livestock.

MATERIALS AND METHODS

Samples of selected rabi and kharif fodders were collected from fodder research sub-station, AARI, Faisalabad during rabi and kharif season. The samples were collected at the stage when the fodder was ready for grazing. Then these samples were chopped, dried, grinded and analyzed for crude protein, crude fiber, ash and crude fat.

Sr. No.	Rabi Fodders	Sr. No.	Kharif Fodders
1	Lucern	5	Sorghum

2	Berseem	6	Maize
3	Oat	7	Pearl millet
4	Rye grass	8	Rhode grass

RESULTS AND DISCUSSION

Rabi fodders

The results regarding nutritional quality of different Rabi fodders are given in table-19

Crude protein

Crude protein in various rabi fodders varied from 8.60 % to 20.90 %. Maximum crude protein (20.90 %) was found in lucern and minimum crude protein (8.60%) was found in oat.

Crude fat

Crude fat in different Rabi fodders varied from 1.32% to 1.96 %. Maximum crude fat (1.96 %) was found in Rye grass and minimum crude fat (1.32%) was found in lucern.

Crude fiber

Results depicted that crude fiber varied in various rabi fodders from 14.66 % to 23.94 %. Maximum crude fiber (23.94 %) was found in oat and minimum crude fiber (14.66%) was found in berseem.

Ash content

Ash contents in different Rabi fodders varied from 8.89% to 14.95 %. Maximum ash contents (14.95 %) was found in berseem and minimum ash contents (8.89 %) was found in oat.

Kharif fodders

The results regarding nutritional quality of different kharif fodders are given in table-20

Crude protein

Crude protein in various kharif fodders varied from 7.58 % to 11.41 %. Maximum crude protein (11.41%) was found in maize fodder and minimum crude protein (7.58%) was found in sorghum.

Crude fat

Crude fat in different kharif fodders varied from 2.25% to 2.82 %. Maximum crude fat (2.82 %) was found in pearl millet and minimum crude fat (2.25%) was found in rhode grass.

Crude fiber

Results depicted that crude fiber varied in kharif fodders from 25.23 % to 34.67 %. Maximum crude fiber (34.67 %) was found in rhode grass and minimum crude fiber (25.23%) was found in maize fodder.

Ash content

Ash contents in different kharif fodders varied from 7.67 % to 8.87 %. Maximum ash contents (8.87%) was found in rhode grass and minimum ash (7.67%) was found in sorghum fodder.

CONCLUSION

It is concluded that in Rabi fodders lucern and berseem are considered as good fodders due to having high protein contents 20.90 % and 18.59 % respectively. While in kharif fodders Maize and rhode grass are considered as good fodders due to having high protein contents 11.41 % and 10.99 % respectively.

Table-19: Chemical composition of Rabi fodders

Sr. No.	Name of fodders	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
1	Lucern	20.90	1.32	22.46	10.09
2	Berseem	18.59	1.35	14.66	14.95
3	Oat	8.60	1.76	23.94	8.89
4	Rye grass	12.44	1.96	23.04	12.40

Table-20: Chemical composition of Kharif fodders

Sr. No.	Name of fodders	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
1	Sorghum	7.58	2.41	26.54	7.67
2	Maize	11.41	2.52	25.23	8.50
3	Pearl millet	9.04	2.82	25.95	8.70
4	Rhode grass	10.99	2.25	34.67	8.87

11. NUTRITIONAL QUALITY EVALUATION OF DIFFERENT PLUM (*Prunus domestica*) VARIETIES

INTRODUCTION

Plum (*Prunus domestica* L.) is a temperate zone fruit crop, which belong to the genus *Prunus* of subfamily *Amygdaloideae*, family *Roseaceae*. Plums have abundant of bioactive compounds such as antioxidants, organic acid, (citric and malic acids). Plum is an important stone fruit after peach in terms of area and production in Pakistan. The colour of the outer skin may vary considerably from yellow or dark red to purple or black. Plums are an excellent source of vitamins such as vitamin C (ascorbic acid). Present study is designed to evaluate the nutritional quality of different plum varieties grown at Horticultural Research Station, Nowshera (Soon Valley) Khushab.

MATERIALS AND METHODS

This experiment was conducted in collaboration with Horticultural Research Station, Nowshera (Soon Valley) Khushab. Five varieties of plum Shakar Proon, Mathely, Santa Rosa, Heri Saminor and Red Bueat were collected from Horticultural Research Station, Nowshera (Soon Valley) Khushab during the month of June 2019. Fifteen samples of each variety were collected and analyzed for ascorbic acid (Vitamin C), malic acid, TSS, sugars, pulp %, fruit weight, firmness and antioxidant activity. Results are presented as average of fifteen samples

RESULT AND DISCUSSION

The results regarding chemical composition of plum varieties are given in table-19 and 20

Total soluble solids (TSS):

TSS of fresh plum samples ranged from 10.2 to 17.3 %. Maximum TSS (17.3 %) was recorded in variety Santa Rosa while minimum TSS (10.2 %) was recorded in variety Red Bueat.

Malic acid:

Malic acid of different plum varieties ranged from 0.62 to 0.90 %. Maximum malic acid (0.90%) was recorded in variety Mathely and minimum (0.60%) was present in variety Shakar Proon.

Vitamin-C:

Among all the five plum varieties vitamin C was higher in variety Mathely (9.45 mg/100 g) whereas lower value was observed in Shakar Proon (6.74 mg/100g).

Reducing sugar:

Data regarding analysis of fresh plum juice for reducing sugar ranged from 6.37 to 6.74 %. Maximum reducing sugar (6.74%) was recorded in variety Methley while minimum reducing sugar (6.37%) was present in variety Red Bueat.

Total invert sugar:

Total invert sugar recorded in fresh plum juice ranged from 10.1 to 12.2 %. Maximum total invert sugar (12.2%) was present in variety Shakar Proon while minimum total invert sugar (10.1%) was recorded in variety Red Bueat.

Fruit Weight (g/fruit):

Fruit weight of plum varieties ranged from 12.4 to 52.9 g. Maximum fruit weight (52.9g) was observed in variety Red Bueat while minimum fruit weight (12.4 g) was noticed in variety Methley.

Firmness:

Firmness recorded in fresh plum fruit ranged from 1.03 to 1.96 kg. Maximum firmness (1.96kg) was observed in variety Heri Saminor while minimum firmness (1.03kg) was recorded in variety Red Bueat.

Pulp %:

Among the five plum varieties pulp % was higher in variety Red Bueat (86.7%) whereas lower value was observed in Methley (78.5%).

Antioxidant % DPPH activity:

Antioxidant recorded in fresh plum fruit ranged from 87.9 to 89.3%. Maximum antioxidant activity (89.3%) was recorded in variety Shakar Proon while minimum antioxidant activity (87.9%) was recorded in variety Heri Saminor.

Table-19: Nutritional composition of different plum varieties

Varieties	Fruit Weight (g/fruit)	Firmness (kg)	Pulp %	Malic Acid (%)
Methley	12.4 e	1.41 b	78.5 c	0.90 a
Shakar Proon	17.5 d	1.84 a	80.0 c	0.79 b
Heri Saminor	26.3 c	1.96 a	78.9 c	0.89 a
Santa Rosa	30.9 b	1.87 a	82.2 b	0.62 d
Red Bueat	52.9 a	1.03 c	86.7 a	0.70 c
LSD	1.54	0.12	0.96	0.03

Table-20: Nutritional composition of different plum varieties

Variety	TSS (%)	Vitamin C (mg/100g)	Reducing sugar (%)	Total sugar (%)	Antioxidant % DPPH activity
Methley	16.5 a	9.45 a	6.74 a	10.4 c	87.3 c
Shakar Proon	16.4 b	6.74 d	6.70 ab	12.2 a	88.6 b
Heri	14.8 b	9.22 ab	6.51 bc	10.0 c	87.9 c

Saminor					
Santa Rosa	17.3 c	8.30 c	6.72 a	10.9 b	89.3 a
Red Bueat	10.2 d	8.90 b	6.39 c	10.1 c	88.9 ab
LSD	0.38	0.21	0.11	0.24	0.26

CONCLUSION

It is concluded that varieties Methley and Shakar Proon were comparatively better than all other varieties due to higher vitamin C (9.45mg/100g) of Methley and high total sugars (12.2%) of Shakar Proon

12. EFFECT OF SOWING TIME ON WHEAT GRAIN YIELD AND ITS FLOUR QUALITY

INTRODUCTION

A number of reasons changed the climate of the world. Climate changes include the rise in temperature; shorten the period of winter and many others. This changed climate may affect the yield as well as quality of crops. A study is therefore planned to see the effect of sowing time on the yield and quality of wheat grain.

MATERIAL AND METHODS

Wheat variety galaxy was sown in the field in various months starting from October-2019 and last sowing was done on 10 Januaey-2020 according to the following sowing plan. The interval of sowing was 10 days. Recommended fertilizer dose (NPK 120-90-70kg ha^{-1}) was applied. The layout design was RCBD with four replications. All the agronomic practices were kept uniform for each plot sown at different time. Harvesting was done in April and May, 2020. At harvesting, yield data was collected from each plot and grain samples were analyzed for crude protein, crude fat, ash and fiber contents.

Sowing plan

Treatments	Sowing Time	Treatments	Sowing Time	Treatments	Sowing Time
T_1	10-10-2019	T_5	20-11-2019	T_9	31-12-2019
T_2	20-10-2019	T_6	02-12-2019	T_{10}	20-01-2020
T_3	01-11-2019	T_7	11-12-2019	-	-
T_4	11-11-2019	T_8	20-12-2019	-	-

RESULTS AND DISCUSSION

Sowing time significantly decreased the grain yield. Maximum grain yield was obtained from the crops sown during the month of November and lowest yield was observed in the plots sown during the month of early January. Regarding the quality parameters of grain, random variation was observed and results were not conclusive but it was evident that delay in sowing up to January had no significant deteriorating effect on the nutrition quality of wheat gain. The results regarding differential response of sowing times towards nutritional quality is given in table-20.

Grain yield:

Grain yield varied from 1.90 (ton/ha) to 4.95 (ton/ha), maximum yield was found in wheat sown on 11 November and minimum in wheat sown on 10 January. The grain yield (4.85, 4.95 and 4.70 t/ha) obtained from the plots sown during the November was statistically at par.

Crude protein:

Crude protein varied from 10.36 to 12.29 %, maximum was found in wheat grain sown on 01 November and minimum in wheat grain sown on 31 December.

Crude fat:

Crude fat varied from 1.0 to 1.38 %, maximum was found in wheat sown on 10 October and minimum in wheat grain sown on 10 January.

Crude fiber:

Crude fiber varied from 0.95 to 1.34%, maximum was found in wheat sown on 20 November and minimum in wheat grain sown on 10 January.

Ash content:

Ash contents varied from 0.88 to 1.19 %, maximum was found in wheat sown on 10 October and minimum in wheat grain sown on 31 December.

CONCLUSION

It is concluded that sowing in November was found best for wheat due to having high grain yield (4.95 t/ha), crude protein (11.85 %), crude fat (1.36 %), crude fiber (1.34 %) and ash (1.11 %) contents.

Table-20: Chemical composition of wheat grain

Sr. No	Sowing Time	Yield (ton/ha)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Ash (%)
T_1	(10-10-2019)	3.45cd	10.95bc	1.38a	1.13abc	1.14
T_2	(20-10-2019)	4.15b	11.15bc	1.26abc	1.08bc	1.01
T_3	(01-11-2019)	4.85a	12.29a	1.18abc	1.11bc	1.19
T_4	(11-11-2019)	4.95a	11.85ab	1.29ab	1.21ab	1.03
T_5	(20-11-2019)	4.70ab	12.11a	1.36a	1.34a	1.11
T_6	(02-12-2019)	4.15b	11.66ab	1.17abc	1.01bc	1.16
T_7	(11-12-2019)	4.05bc	11.55ab	1.34ab	1.19ab	0.93
T_8	(20-12-2019)	3.20d	11.78ab	1.13abc	1.13abc	1.14
T_9	(31-12-2019)	2.80d	10.36c	1.06bc	1.23ab	0.88
T_{10}	(10-01-2020)	1.90e	10.41c	1.0c	0.95c	0.91

13. INFLUENCE OF BIOCHAR APPLICATION ON NUTRITIONAL QUALITY CHARACTERISTICS OF TOMATO UNDER DROUGHT STRESS

INTRODUCTION

Tomatoes are one of the most nutritionally and economically important crops around the world. Tomatoes require large amount of water to grow well and are adversely affected by drought stress. Pakistan is facing serious water shortage and crisis is around the corner. It is reported that biochar (unburnt carbon prepared by controlled burning of plant materials) acts as soil conditioner and improves the water holding capacity. This ability of biochar may reduce the deteriorative effect of water stress. Present study was planned to assess the effect of biochar application on quality of tomatoes grown under water stress conditions.

MATERIALS AND METHODS

A pot experiment was conducted at Biochemistry Section, PHRC, Faisalabad. Tomato nursery was transplanted in pots during February, 2020. Biochar amendments at the rate mentioned below were mixed with soil before pot filling. Pots were filled with 12 kg well mixed sieved soil amended with biochar at the prescribed levels. Moisture of soil was maintained at levels 70, 60 and 50% of field capacity throughout the experimental period. The saturation

percentage of soil was 33%. Three pickings of tomato were taken and composite samples from each picking were collected for nutritional quality analysis. One picking is considered as replication and results are represented as average of three replications. Completely randomized design was used as experimental layout with four treatments (levels of moisture) and two factors (levels of biochar)

Treatments (Moisture Levels)

1. 50% of field capacity
2. 60% of field capacity
3. 70% of field capacity
4. 100% of field Capacity

Factors (Biochar Levels)

1. 1% (w/w) of the soil used for experiment
2. 2% (w/w) of the soil used for experiment

RESULTS AND DISCUSSION

The results regarding influence of biochar application on nutritional quality characteristics of tomato under drought stress are given in table 22 to 25

Crude protein:

Application of 2% biochar mitigates the impact of drought up to 70% of field capacity. Results showed that crude protein contents ranged from 1.38 to 1.98%. Higher crude protein content (1.98%) was observed at 70% field capacity with 2% biochar application as compared to crude protein contents (1.89%) observed in control (100% field capacity). Minimum crude protein content (1.38%) was analyzed at 50% field capacity with 1% biochar application.

Crude fat:

Application of 2% biochar mitigates the impact of drought up to 70% of field capacity. Results showed that crude fat ranged from 0.43% to 0.86%. Higher crude fat (0.86%) was observed at 100% field capacity with 2% biochar application. Minimum crude fat (0.43%) was observed at 50% field capacity with 2% biochar application.

Crude fiber:

Application of 2% biochar reduced the impact of drought up to 70% of field capacity. Results showed that crude fiber content ranged from 2.98 to 3.96%. Higher crude fiber (3.96%) was observed at 100% field capacity with 2% biochar application Minimum crude fiber (2.98%) was observed at 50% field capacity with 1% biochar application.

Ash content:

Application of 2% biochar alleviates the effect of drought up to 70% of field capacity. Results showed that ash content in tomato varied from 5.15% to 6.18%. Higher ash contents (6.18%) was observed at 50% field capacity with 1% biochar application, while minimum ash content (5.15%) was observed at 50% field capacity with 1% biochar application.

CONCLUSION

Biochar suppressed the effect of water stress upto 70% field capacity. The quality parameters were observed comparatively better with the application of 2% biochar under drought stress as compared to control (100% field capacity). Maximum crude protein (1.98 %) was observed at 70% field capacity with 2% biochar application while crude fat (0.86 %), crude fiber (3.96%), ash (6.18%) was observed at 100% field capacity with 2% biochar application.

Table -22: Effect of biochar application on crude protein of tomato under drought stress

Moisture level	1% biochar	2% biochar	Mean
50% field capacity	1.38	1.56	1.47
60% field capacity	1.51	1.69	1.60
70% field capacity	1.72	1.98	1.85
100% field capacity (control)	1.89	1.77	1.83
Mean	1.63	1.75	

Table -23: Effect of biochar application on crude fat of tomato under drought stress

Moisture level	1% biochar	2% biochar	Mean
50% field capacity	0.56	0.43	0.50
60% field capacity	0.63	0.51	0.57
70% field capacity	0.59	0.79	0.69
100% field capacity (control)	0.74	0.86	0.80
Mean	0.63	0.65	

Table -24: Effect of biochar application on crude fiber of tomato under drought stress

Moisture level	1% biochar	2% biochar	Mean
50% field capacity	2.98	3.21	3.10
60% field capacity	3.12	3.56	3.34
70% field capacity	3.36	3.88	3.62
100% field capacity (control)	3.62	3.96	3.79
Mean	3.27	3.65	

Table -25: Effect of biochar application on ash of tomato under drought stress

Moisture level	1% biochar	2% biochar	Mean
50% field capacity	5.15	5.33	5.24

60% field capacity	5.35	5.51	5.43
70% field capacity	5.49	6.10	5.80
100% field capacity (control)	5.95	6.18	6.07
Mean	5.49	5.78	

14. EFFECT OF MICROBIAL INOCULATION ON NUTRITIONAL QUALITY OF MASH GENOTYPES

INTRODUCTION

Mash bean is an important pulse crop used in Pakistan. It has great value as food, in addition to its ability to improve the soil fertility. It is an economic source of protein for human consumption. Inoculation with beneficial microbes plays a key role in nodulation and hence increases the yield and quality. Present study was therefore designed to evaluate the role of microbial inoculation in nutritional value addition to different varieties/lines of mash.

MATERIALS AND METHODS

Crop was sown at field area of Pulses Research Institute, Faisalabad by opting necessary agronomic practices following RCBD with three replications. Recommended dose of NP (25-60 kg ha^{-1}) were applied at the time of sowing. One set of treatment was inoculated with microbial strains while the other remains un-inoculated and treated as control. Two varieties and four lines were taken as experimental material to test the efficacy of microbial inoculation. Samples were collected, dried, ground and analyzed for crude protein, crude fat, crude fiber and ash.

Sr. No.	Varieties/Lines
1	15M001
2	15M002
3	15M004
4	15M008
5	Mash-97
6	Arooj-2011

RESULTS AND DISCUSSION

The results regarding effect of microbial inoculation on nutritional quality of mash varieties/lines are given in table 26. Microbial inoculation enhanced the overall nutritional quality parameters except crude fat of all varieties and lines of mashbean tested. The difference between inoculated and un-inoculated was found non-significant.

Crude protein:

The analysis result of mash bean showed that crude protein contents ranged from 23.10 to 24.80%. Maximum crude protein content (24.80%) was recorded in line 15M004 when inoculated. Minimum crude protein content (23.10%) was observed in variety Arooj 2011 un-inoculated.

Crude fat:

Data regarding analysis of mash bean for crude fat revealed that fat contents ranged from 0.86 to 1.28%. Maximum crude fat (1.28 %) was observed in line 15M001 un-inoculated followed by 1.25% in line 15M004 inoculated. Minimum crude fat (0.86 %) was recorded in line 15M008 un-inoculated.

Crude fiber:

Results for crude fiber revealed that crude fiber content ranged from 3.28 to 3.86%. Maximum crude fiber was observed in line 15M004 inoculated (3.86%). Minimum crude fiber was recorded in line 15M002 un-inoculated (3.28 %).

Ash content:

Results of ash content revealed that ash content in mash been varied from 3.35 to 3.90%. Maximum ash content (3.90%) was obtained in variety Arooj 2011 inoculated. Minimum ash content (3.35%) was found in variety Mash-97 un-inoculated.

CONCLUSION

Microbial inoculation increased the protein contents, crude fiber and ash contents in all the advanced lines and varieties but difference was non-significant. Crude fat remained un-affected. Among lines, line No. 15M004 performed better as compared to other lines where protein was 24.80%.

Table-26: Chemical composition of mashbean varieties/lines as affected by microbial inoculation

Varieties / Lines	Crude protein (%)		Crude fat (%)		Crude fiber (%)		Ash (%)	
	Un-Inc	Inc	Un-Inc	Inc	Un-Inc	Inc	Un-Inc	Inc
15 M 001	23.40bc	23.90cd	1.28a	1.15ab	3.56b	3.76ab	3.52c	3.68b
15 M 002	23.50bc	24.10c	0.92c	1.10ab	3.28c	3.51c	3.48cd	3.57c
15 M 004	24.10a	24.80a	1.25a	1.17a	3.66ab	3.86a	3.80a	3.84a
15 M 008	23.80ab	24.50b	0.86c	1.05b	3.74a	3.58c	3.60bc	3.47d
Mash 97	23.50bc	23.70de	1.04b	1.13ab	3.52b	3.63bc	3.35d	3.40d
Arooj 2011	23.10c	23.60e	0.97bc	1.08ab	3.58b	3.74ab	3.71ab	3.90a
LSD	0.289		0.101		0.138		0.080	

*****Un-Inc= Un-inoculated *Inc= Inoculated

15. DIFFERENTIAL RESPONSE OF MUNG BEAN GENOTYPES TOWARDS NUTRITIONAL QUALITY DUE TO MICROBIAL INOCULATION

INTRODUCTION

Pulses have a special role in food security on account of their ability to reduce protein malnutrition. Mung bean is an important protein source for people. It maintains soil fertility through biological nitrogen fixation in soil and thus plays a vital role in sustainable agriculture. It contains about twice as much protein as cereals. Inoculation with beneficial rhizobacteria plays a key role in nodulation and yield of legumes. Present study was planned to see the effect of microbial inoculum on the quality of five lines and one variety of mung bean.

MATERIALS AND METHODS

Experiment was conducted in collaboration with Pulses Research Institute, Faisalabad. Crop was sown during the month of July. All agronomic practices were carried out. Experimental design was RCBD with three replications. Recommended doses of fertilizer (25-60 N, P kg/ha) was applied at sowing. One set of treatment was inoculated with microbial inoculum while the other remains un-inoculated and treated as control. At harvest, samples were collected, dried, ground and analyzed for crude protein, crude fat, crude fiber and ash.

Following varieties/ lines were tested;

Sr. No.	Varieties/Lines
1	PRI Mung 2018
2	15003
3	14005
4	15002
5	15024
6	15039

RESULTS AND DISCUSSION

The results regarding response of mungbean genotypes towards microbial inoculation are given in table-27. Microbial inoculation enhanced the nutritional quality parameters of a variety and 5 lines of mungbean but the difference between inoculated and un-inoculated was found non-significant.

Crude protein:

The analysis result of mung bean showed that crude protein contents ranged from 22.78 to 24.33%. Maximum crude protein content (24.33%) was found in line 15039 inoculated. Minimum crude protein content (22.78 %) was found in line 15003 when un-inoculated.

Crude fat:

Results of mung bean for crude fat revealed that crude fat contents ranged from 1.22 to 1.86%. Maximum crude fat (1.86%) was observed in line 15039 inoculated followed by 15039 un-inoculated (1.62%). Minimum crude fat (1.22%) was recorded in variety PRI Mung 2018 un-inoculated.

Crude fiber:

Results of mash bean for crude fiber revealed that crude fiber content ranged from 4.48 to 5.32%. Maximum crude fiber was observed in line 15039 (5.32%). Minimum crude fiber was recorded in variety PRI Mung 2018 un-inoculated (4.48 %).

Ash content:

Data regarding ash content revealed that ash content in mung bean varied from 3.37 to 3.83 %. Maximum ash content (3.83%) was obtained from line 15024 inoculated. Minimum ash content (3.37%) was found in line 15039 un-inoculated.

CONCLUSION

Inoculation improved the nutritional quality parameter including crude protein, crude fat, crude fiber and ash of mungbean. Among lines 15039 performed better compared to other lines where crude protein was 24.33%.

Table-27: Chemical composition of mungbean variety/lines as affected by microbial inoculation

Variety / Lines	Crude Protein (%)		Crude Fat (%)		Crude Fiber (%)		Ash (%)	
	Un-Inc	Inc	Un-Inc	Inc	Un-Inc	Inc	Un-Inc	Inc
PRI Mung 2018	23.74a	23.95b	1.22c	1.43c	4.48c	4.56d	3.40c	3.61bc
15003	22.78d	23.07c	1.27c	1.30d	4.60c	4.72c	3.59ab	3.70b
14005	23.01c	23.83b	1.46b	1.60b	4.96ab	4.85c	3.47bc	3.55cd
15002	23.74a	24.01b	1.42b	1.39cd	4.66c	4.72c	3.60ab	3.67bc
15024	23.39b	23.83b	1.30c	1.48c	4.90b	5.17b	3.72a	3.83a
15039	23.80a	24.33a	1.62a	1.86a	5.10a	5.32a	3.37c	3.46d
LSD	0.280		0.109		0.131		0.119	

*Un-Inc= Un-inoculated *Inc= Inoculated

16. ENHANCEMENT OF PROTEIN CONTENTS IN GRAM BY FERTILIZERS MANAGEMENT

INTRODUCTION

Pulses has important role in contributing to food and nutritional security. Pulses are rich in proteins and a cheap source of protein. Gram is an important pulses crop grown in Punjab on light and dry soils especially in the districts of Khushab, Bhakkar, Layyah and Karore. Gram is also high in fiber, as well as a significant source of iron, zinc, potassium and magnesium. By keeping in view the above importance of pulses in human diet, the present study was planned to enhance protein contents in gram by application of balanced fertilizers and inoculating the seed with microbial incoculum.

MATERIALS AND METHODS

A field experiment was conducted in collaboration with Pulses Research Institute, Faisalabad. Gram was sown in Novemeb-2019. Fertilizers were applied according to the treatment plan. Crop management practices were carried out. Experiment was laid out in RCBD with five treatments (fertilizer doses), two factors (Inoculum) and 4 replications. One set of treatment was applied to the crop sown without inoculum (control) while other set of treatments was applied to the crop grown by using seed treated with inoculum obtained from Soil Bacteriology Section AARI, Faisalabad. Samples were collected from each treatment at hravesting, dried, grinded and analyzed for crude protein, crude fat, crude fiber and ash. Following treatments were applied.

Treatments	Fertilizer Dose
T_1	Control (No fertilizer)
T_2	N (30 kg/ha)
T_3	P (90 kg/ha)
T_4	K (30 kg/ha)
T_5	NPK (30+90+30) kg/ha

RESULTS AND DISCUSSION

The results regarding differential response of treatments towards nutritional quality is given in table-28 to 31.

Crude protein:

Fertilizer doses and inoculation increased the protein contents of chickpea. Result showed that crude protein contents ranged from 19.68 % to 25.73%. Maximum crude protein content (25.73%) was recorded in T_5 (NPK (30+90+30) kg/ha+ inoculums) followed by T_4 (K-

30kg/ha+inoculum) where crude protein was 24.4%. Minimum crude protein content (19.68%) was found in control treatment where no fertilizer and no inoculum was applied.

Crude fat:

Fertilizer doses and inoculation increased the crude fat contents of chickpea. Data regarding crude fat revealed that fat contents ranged from 2.75% to 3.37%. Maximum crude fat (3.37%) was analyzed in T5 (NPK (30+90+30) kg/ha). Minimum crude fat was observed in control treatment where no fertilizer and no inoculums was applied.

Crude fiber:

Result showed that fertilizer application had no significant on crude fiber while inoculation increased the crude fiber contents. Crude fiber ranged from 2.37 % to 3.33 %. Maximum crude fiber (3.33%) was analyzed in treatment where (NPK (30+90+30) kg/ha+ inoculums) was applied. Minimum crude fiber (2.37%) was recorded in control treatment.

Ash content:

Result showed that fertilizer application had no significant on ash while inoculation increased the ash contents. Data regarding ash content revealed that ash contents ranged from 2.39 % to 2.91%. Maximum ash content (2.91%) was found in T_3 where P was applied @ 30 kg/ha along with Inoculum, while minimum ash content (2.39 %) was found in T_4 where K was applied @ 30kg/ha.

CONCLUSION

Application of N, P and K alone as well as in combination had a significant effect on quality parameters like crude protein and crude fat, while crude fiber and ash did not effect by fertilizer application. Inoculum played a vital role in enhancing the crude protein, crude fat, crude fiber and ash contents. These parameters increased by treating the seed with inoculum before sowing. The better quality was obtained where NPK was applied (30-90-30 kg/ha) with and without microbial inoculation.

Table-28: Effect of Fertilizer and Inoculum application on crude protein (%) in gram.

Sr. No.	Fertilizer Dose	without Inoculum	with Inoculum	Mean
T_1	No fertilizer	19.68f	21.01e	20.34D
T_2	N (30kg/ha)	22.15de	21.20e	21.67C
T_3	P (30kg/ha)	21.71de	21.08e	21.39C
T_4	K (30kg/ha)	22.84cd	24.41ab	23.62B
T_5	NPK (30:90:30) kg/ha	23.54bc	25.73a	24.63A
	Mean	21.98B	22.68A	

	LSD for inoculums	0.58
	LSD for treatment	0.92
	LSD for interaction	1.30

Table-29: Effect of Fertilizer and Inoculum application on crude fat (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T_1	No fertilizer	2.75e	3.55ab	3.15AB
T_2	N (30 kg/ha)	2.92de	3.36abcd	3.14AB
T_3	P (30 kg/ha)	3.06cde	3.72a	3.39A
T_4	K (30 kg/ha)	3.28abcd	2.76e	3.02B
T_5	NPK (30:90:30) kg/ha	3.37abc	3.11bcde	3.24AB
	Mean	3.07B	3.30A	
	LSD for inoculums	0.20		
	LSD for treatment	0.32		
	LSD for interaction	0.45		

Table-30: Effect of Fertilizer and Inoculum application on crude fiber (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T_1	No fertilizer	2.37d	2.89bc	2.63B
T_2	N (30 kg/ha)	3.01abc	3.35a	3.17A
T_3	P (30 kg/ha)	2.75cd	2.38d	2.56B
T_4	K (30 kg/ha)	2.98abc	3.23ab	3.10A
T_5	NPK (30:90:30) kg/ha	2.99abc	3.33ab	3.16A
	Mean	2.81B	3.03A	
	LSD for inoculums	0.20		
	LSD for treatment	0.32		
	LSD for interaction	0.45		

Table-31: Effect of Fertilizer and Inoculum application on ash contents (%) in gram.

Sr. No.	Fertilizer Dose	Without Inoculum	With Inoculum	Mean
T_1	No fertilizer	2.48ab	2.87a	2.67A
T_2	N (30 kg/ha)	2.44ab	2.71ab	2.57A
T_3	P (30 kg/ha)	2.55ab	2.91a	2.72A
T_4	K (30 kg/ha)	2.39b	2.82ab	2.60A
T_5	NPK (30:90:30) kg/ha	2.63ab	2.84ab	2.73A
	Mean	2.498B	2.83A	
	LSD for inoculums	0.21		
	LSD for treatment	0.33		
	LSD for interaction	0.47		

17. EFFECT OF DRYING METHODS ON THE NUTRITIONAL STATUS OF VEGETABLES PRESERVED BY DRYING

INTRODUCTION

Vegetables are highly perishable due to their high water contents. It is imperative to preserve vegetables in their peak seasons to use them later on. There are number of methods being used for preservation of vegetables. Preservation by drying is the most common and oldest method of vegetable preservation. There are a number of drying methods that removes enough moisture to prevent decay and spoilage. Present study was designed to evaluate nutritional loss of vegetables during drying and find out the best method of drying with least loss of nutrition.

MATERIALS AND METHODS

During the summer, the samples of four vegetables (bitter gourd, tomato, okra, brinjal) were collected. These vegetables were washed for dust removing and after blanching, the vegetables were sliced before drying by using various methods as mentioned in the following treatment plan. The drying process was continued till to the dryness of the vegetables. These dried samples were analyzed for quality parameters i.e. crude protein, crude fat, crude fiber, ash contents.

Treatments are as under:

Treatments	Drying Methods
T_1	Sun drying
T_2	Sun drying under shade
T_3	Oven drying by air circulating oven at 50°C
T_4	Oven drying by air circulating oven at 60°C
T_5	Drying by tunnel dryer at 50°C

RESULTS AND DISCUSSION

Drying methods had no significant effect on the nutritional quality of tomato, bitter gourd, brinjal and okra. All methods were found equally good for preservation of vegetables by drying. However, drying with tunnel dryer at 50°C proved comparatively better method of drying because it dried the vegetables in less time. The detail of results is given below.

Tomato

Crude protein, crude fat, crude fiber and ash contents ranged from 0.85 to1.22%, 0.80 to 1.26%, 3.44 to 4.11 and 4.88 to 5.23% respectively. Maximum crude protein, crude fat and crude fiber were observed by the method in which drying was made at 60^0 C in air drying oven, While maximum ash was found in method drying under shade. Lowest value for ash, crude protein and crude fiber was observed in method where vegetables were dried at 50^0 C in air drying oven, while lowest value for crude fiber was observed by sun drying method.

Bitter gourd

Crude protein, crude fat, crude fiber and ash contents ranged from 5.06 to 6.51 %, 0.35 to 0.59%, 5.02 to 5.37 and 6.11 to 6.79% respectively. Maximum crude protein, crude fiber and ash were observed by the method sun drying under shade. While maximum crude fat was found in drying method of tunnel dryer. Lowest value for ash, crude protein, crude fat and crude fiber was observed in method where vegetables were dried at 50^0 C and 60^0 C in air drying oven.

Brinjal

Crude protein, crude fat, crude fiber and ash contents ranged from 1.01 to1.31%, 0.22 to 0.31%, 0.96 to 1.17 and 0.68 to 0.96% respectively. Maximum ash, crude fat and crude fiber were observed by the method in which drying was made by tunnel dryer. While maximum crude protein was found in sun drying under shade method. Lowest value for crude protein, crude fat, ash and crude fiber was observed in method where vegetables were dried at 50^0 C, 60^0 C and by sun drying under shade method.

Okra

Crude protein, crude fat, crude fiber and ash contents ranged from 2.14 to 2.49%, 0.32 to 0.51%, 0.84 to 1.03 and 1.19 to 1.49% respectively. Maximum crude fat and crude fiber were observed by the method in which drying was made at 60^0 C in air drying oven, While maximum ash and crude protein was found in method drying under sun and by tunnel dryer. Lowest value for ash, crude protein, crude fat and crude fiber was observed in method where vegetables were dried by methods sun drying under shade, drying at 50^0 C and 60^0 C in air drying oven.

CONCLUSION

Drying methods had no significant effect on the nutritional quality of tomato, bitter gourd, brinjal and okra. All methods were found equally good for preservation of vegetables by drying.

Table-32: Effect of drying methods on nutritional composition of tomato.

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	4.96	1.16	1.03	3.44
Sun drying under shade	5.23	1.00	1.15	3.61
Oven drying by air circulating oven at 50^{o} C	4.88	0.85	0.80	3.90
Oven drying by air circulating oven at 60 ^{o} C	5.04	1.22	1.26	4.11
Drying by tunnel dryer at 50^{o}C	5.13	1.15	1.10	4.07
LSD	NS	NS	NS	NS

Table-33: Effect of drying methods on nutritional composition of bitter gourd

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	6.21	6.11	0.41	5.18
Sun drying under shade	6.79	6.36	0.49	5.37
Oven drying by air circulating oven at 50^{o} C	6.11	6.28	0.35	5.07
Oven drying by air circulating oven at 60 ^{o} C	6.48	5.06	0.47	5.02
Drying by tunnel dryer at 50 ^{o} C	6.29	6.51	0.59	5.11
LSD	NS	NS	NS	NS

Table-34: Effect of drying methods on nutritional composition of brinjal

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	0.74	1.09	0.29	1.02
Sun drying under shade	0.83	1.16	0.22	1.11
Oven drying by air circulating oven at 50^{o} C	0.89	1.01	0.31	0.96
Oven drying by air circulating oven at 60 ^{o} C	0.68	1.21	0.23	1.04
Drying by tunnel dryer at 50 ^{o} C	0.96	1.31	0.31	1.17
LSD	NS	NS	NS	NS

Table-35 Effect of drying methods on nutritional composition of okra

Drying Methods	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
Sun drying	1.49	2.28	0.43	0.79
Sun drying under shade	1.19	2.08	0.36	0.84
Oven drying by air circulating oven at 50^{o} C	1.31	2.33	0.32	0.93

Oven drying by air circulating oven at 60 ^{o} C	1.33	2.14	0.51	1.03
Drying by tunnel dryer at 50 ^{o} C	1.38	2.49	0.35	0.99
LSD	NS	NS	NS	NS

B. ANALYSIS SERVICE EXTENDED TO VARIOUS INSTITUTIONS DURING 2019-20

1. 04 samples of Dates (Dokay) fruit received from Horticultural Research Institute, Faisalabad and analyzed for TSS, pH, total sugar, antioxidant, acidity and mineral matter.

Samples	TSS (%)	pH	Acidity (%)	Mineral Matter (%)	Antioxidant % DPPH activity	Total Sugar (%)
P	20.8	5.93	0.21	1.93	72.5	42.7
PP	16.4	5.66	0.17	1.72	68.6	30.6
C	15.7	5.49	0.20	1.83	87.0	30.9
N	17.9	5.87	0.16	1.87	87.2	38.4

2. 09 samples of peas received from Director Vegetable Research Institute, Faisalabad were analyzed for crude protein contents

Sr. No.	Variety / Line	Crude Protein (%)
1	CLIMAX	22.9
2	PEA-09	22.5
3	LINAPAK	22.7
4	CLASSIC	21.7
5	9374	22.8
6	1300-8	22.0
7	SARSABZ	23.1
8	GREENACROSS	22.8
9	METEOR	21.6

3. 20 samples of cookies received from Wheat Research Institute, AARI, Faisalabad and analyzed for ash and crude fat.

Sample No.	Ash (%)	Crude fat (%)
0	1.22	27.75
1	1.57	25.91
2	1.55	26.46
3	1.54	25.90
4	1.57	20.60
5	1.80	26.25
6	1.53	26.06
7	1.67	25.77
8	1.38	25.43

9	2.79	12.78
10	1.53	28.60
11	1.54	27.72
12	1.58	26.82
13	1.78	27.82
14	1.50	27.40
15	1.44	27.65
16	1.45	26.49
17	1.14	27.19
18	1.45	25.15
19	2.61	2.34

4. 01 sample of Maize grain received from CR Cotton Mill Pvt. Ltd, Faisalabad and analyzed for moisture content.

Sample	Moisture %
Maize grain	8.90 ± 0.36

5. 18 samples of fodder crop received from Agronomist (Forage Production), Ayub Agricultural Research Institute, Faisalabad were analyzed for crude protein, crude fiber and ash contents.

Sample No.	Crude protein (%)	Crude fiber (%)	Ash (%)
1	9.20	27.50	10.53
2	8.82	27.90	10.36
3	9.70	30.22	10.02
4	9.54	30.80	11.52
5	9.87	30.60	10.86
6	9.98	28.52	11.15
7	10.24	23.50	11.08
8	10.01	22.90	11.42
9	10.66	23.20	11.38
10	11.21	22.98	11.82
11	10.92	23.15	11.20
12	11.15	22.80	11.44
13	10.56	24.90	10.56
14	11.27	25.20	11.40
15	11.42	25.52	11.10
16	11.50	26.28	11.70
17	11.70	27.88	10.94
18	11.65	26.93	11.25

6. 06 samples of groundnut received from Groundnut Research Station, Attock and analyzed for moisture, crude fat, crude fiber, crude protein and mineral matter.

Varieties / lines	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)
BARI 2016	3.04	2.36	39.7	21.6	2.56
11AK 011	4.16	2.41	40.5	21.6	2.70
PHOTOWAR	3.31	2.41	42.3	22.1	2.91
10AK 003	3.96	2.45	44.2	21.4	2.68
10AK 002	2.86	2.47	40.0	20.1	2.77
BARI 2011	3.68	2.38	41.2	22.7	3.03

7. 02 samples of maize grain received from Agronomic Research Institute, Faisalabad were analyzed for crude fat and crude protein.

Samples	Crude fat (%)	Crude protein (%)
AGR-1	4.22	8.40
AGR-2	4.06	7.76

8. 08 samples of fodders received from Fodder Research Sub-station, Faisalabad were analyzed for dry matter, crude protein, crude fat and crude fiber.

Sample No.	Sample Names	Name of Advance lines	Dry matter (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)
1	Oats	F-11	21.11	7.42	1.78	24.34
2	Oats	F-415	20.86	7.08	1.54	23.65
3	Millets	FB-786	24.34	10.23	3.15	22.53
4	Millets	FB-794	25.55	09.25	4.17	23.98
5	Maize	Maize-2020	24.21	13.43	3.19	24.38
6	Maize	Maize-2025	23.55	12.94	2.84	27.92
7	Sorghum	Sandal Sorghum	27.77	07.94	3.22	27.32
8	Sorghum	AK-113	28.43	07.06	2.82	27.86

9. 13 samples of seeds (chickpea, mungbean, millet, sorghum and oil seed) were received from Regional Agricultural Research Institute, Bahawalpur and analyzed for crude protein and crude fat.

Sr. No.	Sample No.	Samples ID	Crude protein (%)	Crude fat (%)
Chickpea				
1	1	BRC-446 (Desi)	21.40	3.34
2	2	BRC-474 (Desi)	20.09	3.24
3	3	BRC-408 (Desi)	22.06	3.42

4	4	Bittle-2016 (Check)	25.83	3.40
Mungbean				
5	1	BRM-353	23.43	1.29
6	2	BRM-357	24.24	1.22
7	3	NM-2011 (Check)	24.82	1.38
Millet				
8	1	RARI Composit-7	11.88	3.04
9	2	Chollastani Bajra (Check)	12.38	3.11
Sorghum				
10	1	RARI, S-22	11.14	3.00
11	2	JAWAR-86 (Check)	10.88	2.97
Oilseed				
12	1	BRJ-1304	23.63	30.68
13	2	BWP-Raya (Check)	22.07	31.93

10. 02 samples of Mungbean seed received from Director Arid Zone Research Institute Bhakkar were analyzed for crude protein.

Sr. No.	Samples ID	Crude protein (%)
1	13TM-04	22.97
2	13TM-14	22.39

11. 24 samples of mung bean grains received from Agronomic Research Institute, Faisalabad and analyzed for moisture %, crude fat, crude protein and ash.

Treatments	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fat (%)
T1R1	8.82	4.45	1.27	22.3	3.42
T1R2	8.62	4.05	1.37	21.9	3.10
T1R3	7.97	4.15	1.28	22.1	3.15
T2R1	7.71	4.53	1.37	22.9	3.36
T2R2	7.42	4.13	1.50	22.1	3.64
T2R3	7.83	4.41	1.39	22.4	3.40
T3R1	8.67	4.28	1.53	22.3	3.83
T3R2	8.52	4.04	1.45	21.3	3.51
T3R3	8.64	4.00	1.67	20.8	3.28
T4R1	6.94	4.18	1.68	21.9	3.56
T4R2	7.06	4.15	1.38	21.4	3.30

T4R3	6.76	4.29	1.54	21.0	3.35
T5R1	6.45	3.92	1.81	23.2	4.02
T5R2	7.11	3.45	1.45	22.6	3.94
T5R3	6.88	3.80	1.63	22.8	3.94
T6R1	6.25	3.92	1.94	23.5	3.82
T6R2	6.62	3.58	1.47	22.9	3.43
T6R3	6.94	3.68	1.53	23.2	3.61
T7R1	7.26	3.77	1.78	23.4	3.59
T7R2	7.33	3.53	1.86	22.9	3.63
T7R3	7.41	3.67	1.79	23.0	3.40
T8R1	6.67	4.50	1.39	23.7	3.71
T8R2	6.90	4.17	1.29	23.5	3.59
T8R3	6.45	4.32	1.42	22.8	3.36

12. 24 samples of fodder received from Forage production Section AARI, Faisalabad were analyzed doe dry matter, crude protein, crude fat and crude fiber, ash and NFE.

Sr. No.	Samples	dry matter (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)	NFE
1	T7R1	23.37	8.48	1.57	25.43	10.33	54.19
2	T6R1	22.73	8.78	2.63	25.12	8.17	55.40
3	T7R2	23.16	7.97	1.96	26.23	9.98	53.60
4	T6R2	22.17	8.75	2.13	24.84	7.83	56.45
5	T5R2	25.44	8.20	2.36	24.28	8.44	60.72
6	T8R2	23.97	8.19	2.12	26.48	11.90	51.31
7	T5R1	24.74	7.55	2.13	23.87	9.41	56.74
8	T8R1	23.32	8.70	1.66	26.38	9.54	63.73
9	T4R1	25.16	8.27	1.84	24.82	10.11	54.96
10	T4R2	25.26	8.41	2.06	24.63	10.29	54.82
11	T3R1	24.56	8.46	1.81	24.10	8.76	56.88
12	T3R2	25.27	7.86	2.23	28.85	9.98	55.09
13	T2R1	24.21	8.89	1.94	23.75	9.30	56.15
14	T2R2	23.57	8.390	1.29	23.60	10.06	66.16
15	T1R2	23.80	8.56	2.11	25.43	9.41	54.39
15	T1R1	23.64	8.74	1.8	24.94	9.65	54.79
17	T7R3	22.85	7.46	1.67	25.97	9.34	55.56
18	T8R3	23.18	8.46	1.95	27.12	10.42	52.05
19	T6R3	22.58	8.28	2.64	25.38	7.65	56.05
20	T5R3	25.31	8.37	2.25	24.10	8.94	56.34
21	T4R3	24.98	8.52	2.13	23.97	9.82	55.56
22	T3R3	25.10	8.23	1.78	23.41	9.25	57.33
23	T2R3	24.28	9.14	2.07	24.06	9.72	55.01
24	T1R3	23.38	8.53	2.22	25.32	9.12	54.81

13. 04 samples of mungbean lines received from Principal Scientist, Leader Mungbean and Lentil Group, NIAB were analyzed for crude fat, crude protein and ash.

Sample No.	Sample Name	Crude protein (%)	Crude fat (%)	Ash (%)
1	NM-16	18.81	1.02	3.51
2	NM-19	20.91	1.18	3.68
3	NM-201 St- check	16.45	0.98	3.45
4	AZRI-2018 St-check	22.38	1.23	3.69

14. 09 samples of mungbean grains received from Agronomic Research Institute, Faisalabad and analyzed for moisture %, crude fat, crude fiber, crude protein and mineral matter.

Sample ID	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)
F1	7.81	3.53	1.51	20.8	3.79
F2	7.14	3.78	1.77	19.9	3.42
F3	7.69	3.07	1.82	23.1	3.17
F4	6.06	3.28	1.32	20.4	3.56
F5	6.23	4.05	1.84	22.1	3.62
F6	6.01	3.28	1.56	21.7	3.77
F7	6.65	3.82	1.68	22.9	3.52
F8	6.93	3.21	1.76	22.4	4.11
F9	7.40	3.37	1.44	23.3	3.57

15. 22 samples of kinnow juice received from Horticultural Research Institute, Faisalabad and analyzed for acidity, pH, TSS, vitamin C, reducing and non-reducing sugar, total sugars and antioxidant activity.

Sr. No.	pH	TSS	Acidity (%)	Reducing Sugar (%)	Total Sugar (%)	Vitamin C (mg/100g)	Non reducing sugar (%)	Antioxidant % DPPH activity
1	3.72	8.30	1.19	2.71	6.10	38.5	3.21	89.5
2	4.12	8.40	1.21	2.57	6.37	42.3	3.61	92.4
3	4.29	9.20	0.63	3.06	8.26	30.8	4.94	91.7
4	4.22	7.40	1.00	2.79	7.08	34.6	4.07	87.2
5	4.03	10.1	0.82	2.38	9.66	42.3	6.91	90.1
6	4.13	7.80	0.88	2.59	7.02	30.8	4.20	92.0
7	4.02	10.1	0.68	3.17	9.27	34.6	5.80	92.1
8	4.44	7.90	0.66	2.77	8.57	38.5	5.51	92.9
9	4.43	6.50	0.69	3.31	9.19	26.9	5.59	91.2
10	4.23	6.90	0.44	3.20	10.6	30.8	6.99	89.4
11	4.29	7.30	0.74	2.61	9.66	34.6	6.69	90.6
12	4.23	7.20	0.73	3.52	7.50	38.5	3.78	91.7
13	4.24	8.00	0.54	3.61	7.92	30.8	4.09	92.8
14	4.17	10.3	0.57	2.64	7.70	34.6	4.81	91.2
15	4.38	7.10	0.89	3.24	8.64	30.8	5.13	92.5
16	4.40	8.10	0.79	2.79	10.0	38.5	6.85	94.3
17	4.48	7.50	0.89	2.85	7.97	30.8	4.87	92.5
18	4.24	6.30	0.7	3.20	9.34	34.6	5.83	94.2
19	4.08	7.50	0.86	2.54	7.60	38.5	4.80	94.3
20	4.34	8.10	0.95	3.48	7.31	30.8	3.64	90.9
21	4.40	8.40	0.66	2.97	8.91	34.6	5.64	93.1
22	4.38	7.70	0.36	3.10	8.64	42.3	5.26	91.3

16. 06 samples of Banana received from Post Harvest Research Centre, Faisalabad and analyzed for vitamin C, reducing and total sugars.

Treatments	Reducing sugar (%)	Total sugar (%)	Vitamin C (mg/100g)
Mature Banana	1.27	4.65	7.14
T1	3.80	15.0	1.94
T2	1.03	4.14	7.76
T3	0.95	4.06	11.6
T4	0.97	4.38	9.71
T5	Not detected		11.6

17. 24 samples of maize silage received from Agronomist (Forage production), Faisalabad and analyzed for dry matter, ash, crude protein, crude, fiber and crude fat.

Sr. No	Sample ID	Dry matter (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1	T1R1	33.11	7.51	1.43	24.93	8.31
2	T1R2	34.55	6.06	1.30	25.33	7.17
3	T1R3	31.22	6.78	1.65	24.15	7.75
4	T2R1	34.65	6.33	1.90	24.98	6.56
5	T2R2	34.58	7.1	2.18	26.25	7.70
6	T2R3	30.33	6.71	2.05	27.28	6.65
7	T3R1	36.19	6.68	1.86	28.45	8.05
8	T3R2	34.65	7.12	1.64	29.08	7.88
9	T3R3	32.15	6.90	1.75	30.20	7.68
10	T4R1	29.92	5.75	1.94	30.38	7.00
11	T4R2	28.57	5.3	1.60	28.14	7.17
12	T4R3	27.20	5.52	2.03	27.84	7.25
13	T5R1	32.56	5.35	1.72	28.25	8.05
14	T5R2	33.61	5.42	1.83	27.63	9.53
15	T5R3	21.45	5.38	1.84	26.11	8.65
16	T6R1	32.98	6.33	1.06	23.46	7.17
17	T6R2	33.17	5.08	1.15	22.03	8.31
18	T6R3	30.63	5.70	1.25	22.43	8.45
19	T7R1	32.59	5.13	2.39	27.23	8.75
20	T7R2	34.39	5.23	2.78	26.55	8.05
21	T7R3	31.24	5.45	2.15	25.32	8.35
22	T8R1	33.6	5.65	1.52	25.45	9.36
23	T8R2	35.92	5.18	1.43	26.77	8.35
24	T8R3	34.16	5.32	1.30	24.15	8.74

18. 22 samples of different maize silage and different fodders (Maize, cowpea, sadabhar) received from Director, Fodder Research Institute, Sargodha and analyzed for ash, crude fat, crude fiber and crude protein.

Sr. No	Sample ID	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
MAIZE SILAGE					
1	YH-1898	5.26	1.71	21.49	6.48
2	YH-1898	6.32	1.56	20.52	7.35
3	SGD-2002	5.88	2.10	22.75	7.79
4	SGD-2002	6.14	2.06	23.74	7.88
5	Pearl Maize	7.07	2.85	25.03	8.63
6	Pearl Maize	7.16	2.91	26.64	8.58
7	1 (A)	6.68	1.96	24.34	5.08
8	2 (B)	6.73	1.71	25.23	6.33
MAIZE FODDER					
9	A	7.07	1.44	22.85	8.66
10	B	8.04	1.76	23.74	9.37
11	C	8.49	3.43	24.66	11.43
12	D	7.11	2.89	24.54	10.51
13	E	7.05	1.64	23.05	09.10
14	F	7.3	1.66	23.25	09.76
15	G	7.41	2.46	24.38	10.21
16	H	8.34	1.23	22.07	08.15
COWPEAS FODDER					
17	1	10.62	1.83	18.91	17.50
18	2	10.73	2.17	20.45	17.68
19	3	10.47	2.55	19.33	19.86
SADABHAR FODDER					
20	1	5.58	2.15	28.19	3.76
21	2	5.71	2.17	26.15	5.16
22	3	5.06	2.39	25.15	4.03

19. 89 samples of chopped carrots received from Post Harvest Research Centre, Faisalabad were analyzed for moisture, ash, crude fat, crude fiber and crude protein (Fresh weight basis)

Sr.	Sample ID	Moisture %	Ash %	Crude fat (%)	Crude protein (%)	Crude fiber (%)
1	K1L32	87.68	1.03	0.32	1.04	1.25
2	K2L9	88.07	0.99	0.29	1.03	1.23
3	K1L3	88.34	0.94	0.29	0.96	1.25
4	K1L33	88.08	1.10	0.31	1.00	1.16
5	K2L7	86.92	1.19	0.34	1.09	1.24
6	K1L5	88.35	1.08	0.30	0.95	1.23
7	K1L40	87.63	1.08	0.32	1.08	1.23
8	K1L4	87.74	1.02	0.31	1.04	1.13

9	K1L25	87.56	1.03	0.29	1.02	1.25
10	K2L11	87.92	1.15	0.36	1.05	1.23
11	K1L36	87.21	1.19	0.38	1.06	1.21
12	K1L31	87.94	1.12	0.35	1.01	1.16
13	K1L27	88.29	1.16	0.29	0.97	1.18
14	K1L24	87.86	1.18	0.30	1.01	1.23
15	K1L37	87.82	1.16	0.29	1.03	1.18
16	K1L26	87.65	1.12	0.37	1.02	1.19
17	K1L29	87.94	1.11	0.35	1.04	1.29
18	K1L22	88.15	1.10	0.35	0.98	1.25
19	K1L2	87.80	1.04	0.33	1.04	1.23
20	K1L42	87.75	1.02	0.34	0.99	1.22
21	K1L2	87.52	1.08	0.33	1.04	1.18
22	K1L13	87.33	1.08	0.39	1.08	1.27
23	K1L9	88.04	1.03	0.40	0.98	1.24
24	K1L35	88.24	0.98	0.38	1.01	1.17
25	K1L23	87.70	1.19	0.32	1.04	1.26
26	K1L21	87.85	1.13	0.32	0.97	1.19
27	K1L10	87.61	1.12	0.32	1.04	1.21
28	K1L46	87.86	1.18	0.35	1.01	1.25
29	K1L43	87.06	1.17	0.37	1.09	1.23
30	K1L38	87.80	1.13	0.34	1.06	1.26
31	K3L23	87.87	1.16	0.34	0.99	1.25
32	K2L37	88.69	1.08	0.31	0.89	1.11
33	K2L23	87.68	1.16	0.33	1.00	1.18
34	K1L8	88.22	1.13	0.29	0.97	1.25
35	K1L41	87.46	1.19	0.30	1.06	1.28
36	K3L18	88.14	1.13	0.28	1.02	1.17
37	K1L19	88.15	0.98	0.35	1.00	1.17
38	K1L28	88.04	1.11	0.32	1.01	1.13
39	K3L6	88.06	1.08	0.33	0.98	1.14
40	K3L27	87.42	1.17	0.34	1.09	1.22
41	K3L28	87.22	1.20	0.34	1.08	1.23
42	K2L12	87.72	1.17	0.32	1.02	1.18
43	K3L15	87.62	1.17	0.36	1.08	1.23
44	K3L9	87.68	1.17	0.37	1.05	1.21
45	K3L30	88.10	1.01	0.34	1.00	1.13
46	K2L2	87.69	1.18	0.30	1.05	1.22
47	K1L11	88.02	1.05	0.30	1.05	1.14
48	K1L34	87.20	1.26	0.29	1.06	1.18
49	K3L19	88.16	1.07	0.29	1.04	1.25
50	K3L11	88.01	1.07	0.30	1.00	1.23
51	K1L47	87.41	1.14	0.29	1.07	1.14
52	K2L33	87.71	1.15	0.31	1.00	1.11
53	K3L17	86.54	1.16	0.32	1.14	1.18
54	K2L14	87.63	1.15	0.31	1.03	1.22

55	K3L14	87.98	0.99	0.28	0.95	1.25
56	K3L43	88.12	1.11	0.25	0.97	1.21
57	K2L5	87.59	1.15	0.29	1.04	1.21
58	K2L4	87.31	1.15	0.33	1.02	1.13
59	K2L6	88.20	1.06	0.32	0.98	1.21
60	K1L20	88.22	1.06	0.31	1.03	1.18
61	K3L5	86.75	1.20	0.32	1.14	1.23
62	K2L24	87.25	1.14	0.32	1.08	1.18
63	K2L20	87.55	1.14	0.29	1.01	1.23
64	K2L42	87.65	1.10	0.26	1.07	1.13
65	K3L12	86.79	1.15	0.30	1.10	1.17
66	K3L26	88.03	1.09	0.29	1.02	1.24
67	K2L16	87.87	1.11	0.33	1.05	1.18
68	K3L4	87.86	1.01	0.32	1.01	1.23
69	K3L13	87.71	1.03	0.32	1.00	1.15
70	K2L34	87.36	1.04	0.29	1.05	1.26
71	K3L16	88.07	1.08	0.31	1.00	1.26
72	K2L27	87.90	1.10	0.31	0.98	1.18
73	K2L36	88.04	1.10	0.28	0.99	1.17
74	K2L26	87.96	1.07	0.30	0.95	1.15
75	K3L24	87.58	1.14	0.28	1.05	1.12
76	K2L29	88.02	1.09	0.34	1.04	1.23
77	K2L28	86.85	1.19	0.37	1.05	1.21
78	K2L15	87.78	1.06	0.35	1.04	1.24
79	K3L20	88.11	1.07	0.28	0.99	1.16
80	K3L2	88.34	1.00	0.28	0.93	1.11
81	K1L39	87.76	1.03	0.30	1.01	1.18
82	K3L27	88.21	1.05	0.29	0.99	1.20
83	K2L31	87.74	1.04	0.34	1.06	1.20
84	K2L32	87.15	1.19	0.34	1.03	1.16
85	K2L44	88.24	1.10	0.27	0.96	1.12
86	K2L18	87.54	1.01	0.35	1.08	1.19
87	K2L39	87.93	1.08	0.29	1.01	1.15
88	K2L38	87.43	1.14	0.36	1.21	1.11
89	K2L41	87.40	1.17	0.36	1.05	1.22

20. 18 samples of maize grain received from Soil Chemistry Section, Faisalabad were analyzed for crude fiber and crude protein

Sample ID	Crude protein (%)	Crude fiber (%)
1	7.53	1.94
2	7.88	1.99
3	7.70	1.91
4	7.88	1.90
5	7.70	1.96

6	8.05	1.94
7	8.75	2.08
8	8.58	2.00
9	8.23	2.09
10	8.58	1.91
11	8.23	2.01
12	8.93	2.02
13	8.75	2.03
14	8.23	1.93
15	8.58	2.03
16	8.40	1.96
17	8.93	2.12
18	8.75	2.02

21. 04 samples of wheat leaf received from Wheat Research Institute, Faisalabad and analyzed for moisture, ash, crude fat, crude fiber and crude protein.

Sample ID	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)
T1	8.76	7.25	2.21	12.3	24.1
T2	8.30	6.32	2.08	11.4	21.3
T3	7.68	7.06	2.18	11.9	21.7
T4	8.10	6.77	2.26	12.6	23.2

22. 39 samples of oat fodder received from Fodder Research Institute, Sargodha and analyzed for dry matter, ash content, crude fat, crude fiber and crude protein.

Sr. No	Sample ID	Moisture %	Ash %	Crude fat (%)	Crude protein (%)	Crude fiber (%)
1	Advance F0-02-18	13.2	10.42	1.43	9.63	21.1
2	Advance FRI-683	13.2	10.28	1.33	10.50	22.9
3	Advance FRI-01-18	14.8	9.53	1.35	9.28	22.0
4	Advance No 2088	14.0	10.49	1.29	10.15	23.4
5	Advance No 97081	12.4	10.54	1.21	10.33	23.3
6	Advance No 663	14.0	9.44	1.26	10.68	21.8
7	Advance F 146	13.2	9.19	1.50	9.10	20.6
8	Advance No 615	13.6	9.52	1.21	10.33	22.7
9	Adaptability F 403	14.0	9.23	1.39	9.45	21.5
10	Adaptability No 301	13.2	9.39	1.20	9.63	22.2
11	Adaptability FRI 153	12.0	10.06	1.23	10.15	22.6
12	Adaptability No 668	12.8	9.15	1.59	9.98	23.4
13	Adaptability FRI 152	12.4	10.04	1.33	10.50	21.4

14	Sgd oat 2011	12.8	9.39	1.25	10.68	20.5
15	Adaptability S 2000	14.4	9.29	1.37	9.63	22.4
16	Adaptability F 406	12.4	9.43	1.12	10.33	20.8
17	Adaptability F 401	13.2	10.36	1.34	10.15	21.0
18	Adaptability FRI 6001	13.2	9.84	1.21	9.80	22.6
19	Adaptability FRI 0343	14.4	10.18	1.36	10.50	21.3
20	Adaptability No 669	13.2	10.30	1.41	10.33	21.9
21	CK-1	14.4	9.72	1.37	9.63	19.9
22	No 484910	18.7	10.44	1.29	9.10	20.5
23	Super Green Oat	18.7	10.50	1.16	9.63	22.4
24	26265-11	16.0	9.89	1.29	9.80	20.0
25	59195	17.6	9.50	1.21	10.50	21.7
26	Australian	18.0	10.37	1.36	10.15	21.6
27	591809	15.6	10.33	1.14	10.68	20.8
28	NARC 224130-320	22.0	9.97	1.31	9.80	19.9
29	Fri 01	18.7	10.42	1.13	10.50	22.3
30	486133	16.0	10.21	1.29	10.68	20.7
31	447297	17.3	9.63	1.15	9.45	19.8
32	486133	16.7	10.26	1.21	9.98	20.9
33	Horcon	25.3	10.38	1.27	10.50	21.6
34	National A	13.6	9.60	1.11	9.63	19.5
35	National B	16.0	10.43	1.31	10.50	21.1
36	National C	13.2	9.40	1.18	9.45	19.7
37	National D	13.6	9.30	1.22	10.33	21.7
38	National E	13.6	9.58	1.29	10.68	21.0
39	National F	12.8	10.31	1.22	10.50	21.1

23. 39 samples of tomato fruit received from Agronomy Research Institute (C&P), Faisalabad and analyzed for lycopene and vitamin C.

Sr. No	Treatments	Lycopene (mg/100g)	Vitamin C (mg/100g)
1	T1R1	4.27	17.4
2	T1R2	4.16	16.8
3	T1R3	4.00	17.6
4	T2R1	3.74	15.2
5	T2R2	3.89	14.7
6	T2R3	3.64	14.3
7	T3R1	4.33	15.9
8	T3R2	4.16	15.2
9	T3R3	4.27	16.0
10	T4R1	3.86	16.6
11	T4R2	4.01	17.1
12	T4R3	3.96	16.9
13	T5R1	4.30	13.8
14	T5R2	4.35	14.6
15	T5R3	4.23	14.3
16	T6R1	3.48	15.7
17	T6R2	3.68	15.1
18	T6R3	3.10	14.6
19	T7R1	4.16	17.3
20	T7R2	4.08	16.8
21	T7R3	4.00	16.5
22	T8R1	4.11	15.4
23	T8R2	3.90	15.9
24	T8R3	3.97	14.7
25	T9R1	4.29	16.3
26	T9R2	4.35	15.9
27	T9R3	4.30	16.0
28	T10R1	3.79	17.1
29	T10R2	3.96	17.6
30	T10R3	4.12	16.9
31	T11R1	3.94	14.4
32	T11R2	3.64	14.7
33	T11R3	3.34	15.3
34	T12R1	4.12	13.9
35	T12R2	4.01	13.5
36	T12R3	4.16	14.4
37	T13R1	4.29	16.0
38	T13R2	4.18	16.9
39	T13R3	4.34	17.4

24. 27 samples of oat fodder received from Agronomist forage production, Faisalabad were analyzed for crude protein, Crude fat, Crude fiber and ash content.

Sample No.	Sample ID	Dry matter (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
1	T1R1 (F-411)	13.91	7.65	1.69	23.35	8.01
2	T1R2 (F-411)	12.84	7.95	1.57	23.67	8.13
3	T1R3 (F-411)	12.11	8.11	1.72	22.95	7.81
4	T2R1 (FRI-034)	14.74	8.96	1.82	23.75	8.71
5	T2R2 (FRI-034)	15.88	9.21	1.83	24.25	9.18
6	T2R3 (FRI-034)	16.32	8.46	1.74	23.85	8.65
7	T3R1(FRI-3664/15)	14.88	8.67	1.81	23.19	9.32
8	T3R2 (FRI-3664/15)	14.26	9.82	1.66	22.95	9.69
9	T3R3 (FRI-3664/15)	15.7	8.73	1.75	23.38	8.91
10	T4R1 (Line-3007)	15.35	9.56	1.41	22.61	8.61
11	T4R2 (Line-3007)	15.41	9.12	1.38	22.87	8.91
12	T4R3 (Line-3007)	15.82	9.36	1.34	22.47	8.54
13	T5R1 (FRI-75525)	16.45	8.88	1.79	22.89	9.45
14	T5R2 (FRI-75525)	15.11	9.18	1.68	22.65	8.86
15	T5R3 (FRI-75525)	15.89	9.36	1.74	23.29	9.06
16	T6R1 (FRI-01)	16.55	8.94	1.38	21.74	8.13
17	T6R1 (FRI-01)	16.18	9.45	1.33	21.34	8.35
18	T6R1 (FRI-01)	15.78	9.05	1.44	20.98	8.44
19	T7R1(FRI-03)	15.25	9.58	1.61	21.85	8.29
20	T7R2(FRI-03)	15.85	9.85	1.65	21.05	8.33
21	T7R3(FRI-03)	16.63	9.74	1.58	21.44	8.44
22	T8R1(sgd-01)	16.87	7.48	1.59	21.24	8.21

23	T8R2(sgd-01)	17.12	7.11	1.55	21.45	8.33
24	T8R3(sgd-01)	17.02	7.14	1.61	20.98	8.62
25	T9R1 (Sgd-2011)	16.08	9.23	1.49	22.30	8.21
26	T9R2 (Sgd-2011)	15.78	8.85	1.39	22.54	8.45
27	T9R3 (Sgd-2011)	15.83	9.15	1.51	22.37	8.85

25. 06 samples of fresh fig fruit received from Horticulture Research Institute, Faisalabad and analyzed for TSS, pH, acidity, vitamin C, antioxidants, total sugars.

Sample No.	TSS	pH	Acidity	Vitamin C	Antioxidants	Total sugars
P1	14.1	5.52	0.18	21.3	71.6	11.2
P2	13.3	5.41	0.17	22.4	73.4	10.6
P3	13.8	5.34	0.19	21.7	73.9	10.7
G1	14.8	4.61	0.20	25.4	55.8	6.7
G2	15.3	4.57	0.22	25.7	54.6	5.9
G3	15.7	4.62	0.21	26.1	57.3	6.4

26. 19 samples of fodder (14 of lucern and 5 of barley fodder samples) received from Fodder Research Institute, Sargodha and analyzed for dry matter, ash, crude fat, crude fiber and crude protein.

Lucern Fodder:

Sr. No	Sample ID	Dry Matter (%)	Crude fat %	Ash (%)	Crude protein (%)	Crude fiber (%)
1	Advace Cheema 1	20.7	2.76	12.1	21.3	23.2
2	Advance SW 9601	20.0	2.96	12.9	22.7	22.5
3	Lucern HS 101	19.3	2.83	12.4	21.7	22.6
4	Advance USS 103	18.7	2.86	13.3	23.3	20.8
5	AgdLucern (Check)	19.3	2.27	12.5	21.9	22.5
6	National E1	17.3	2.63	12.5	21.9	23.4
7	National E2	18.7	2.23	13.6	23.7	22.5
8	National E3	18.7	2.48	12.2	21.3	22.3
9	TURK 1-19	17.3	3.31	12.4	21.6	22.2
10	TURK 2-19	18.0	3.28	12.5	21.9	21.4
11	TURK 3-19	18.0	2.59	12.7	22.3	22.1
12	TURK 4-19	18.0	2.28	12.7	22.1	23.1
13	TURK 5-19	18.7	3.24	12.6	22.0	20.6
14	TURK 6-19	16.7	2.86	13.3	23.3	20.0

Barley Fodder:

Sr. No.	Sample ID	Dry Matter (%)	Crude fat %	Ash (%)	Crude protein (%)	Crude fiber (%)
1	E3	21.3	2.49	11.4	11.4	26.3
2	E21	20.7	2.13	10.9	10.5	25.2
3	E7	22.0	2.58	11.4	11.6	26.3
4	E14	24.0	2.83	10.5	11.0	24.6
5	E23	20.0	2.82	10.2	10.7	21.0

27. 31 samples of chopped carrots received from Post Harvest Research Centre, Faisalabad and analyzed for moisture, ash, crude fat, crude fiber and crude protein.

Sr. No	Sample ID	Moisture %	Ash %	Crude fat (%)	Crude protein (%)	Crude fiber (%)
1	KL29	10.28	0.93	0.24	0.84	1.01
2	K4L1	10.06	0.87	0.29	0.82	0.96
3	K4L3	12.11	0.98	0.29	1.00	1.29
4	K4L14	10.49	0.93	0.23	0.88	1.05
5	K4L15	11.98	0.99	0.35	1.05	1.12
6	K2L17	11.51	0.99	0.30	1.02	1.16
7	K4L19	11.09	0.98	0.26	0.92	1.13
8	K4L29	12.29	1.13	0.26	1.01	1.17
9	K4L10	10.50	1.04	0.27	0.85	1.03
10	K4L2	11.20	1.08	0.26	0.93	1.09
11	K4L22	12.74	1.21	0.33	1.11	1.37
12	K4L16	11.62	1.07	0.26	0.89	1.23
13	K2L30	15.59	1.42	0.33	1.20	1.58
14	K2L46	11.52	1.06	0.24	0.88	1.16
15	K3L43	12.35	1.04	0.25	1.02	1.18
16	K3L35	10.51	0.86	0.31	0.85	1.06
17	K4L5	11.54	0.84	0.34	0.90	1.20
18	K4L13	12.17	0.90	0.34	1.01	1.21
19	K9L30	11.27	0.95	0.33	1.01	1.08
20	K3L46	12.97	1.08	0.35	1.11	1.35
21	K4L18	11.53	0.97	0.34	1.02	1.20
22	K3L34	12.41	1.18	0.33	1.05	1.23
23	K3L44	11.11	1.02	0.29	0.91	1.07
24	K4L23	11.65	1.02	0.30	0.99	1.25
25	K3L38	12.22	1.20	0.34	0.95	1.26
26	K4L11	11.76	1.07	0.25	1.02	1.17
27	K4L24	10.29	0.95	0.23	0.78	1.02
28	K4L4	11.89	0.97	0.32	0.92	1.22
29	K4L27	11.03	1.04	0.25	0.92	1.09
30	K1L35	12.27	1.10	0.31	0.96	1.12
31	K2L44	10.88	1.06	0.25	0.96	1.04

Summary of samples received from other institutes

Sr. No.	Name of Institute	Type of samples	No. of samples
1	Agronomic Research Institute, Faisalabad	Maize grain	02
		Mung bean	33
		Oat Fodder	27
		Fodder Crop	42
		Maize Silage	24
		Tomato	39
		Sub-total	167
2	Director Fodder Research Institute Sargodha	Oat fodder	39
		Maize Silage	22
		Lucern fodder	14
		Barley fodder	05
		Sub-total	80
3	Post-Harvest Research Centre, Faisalabad	Chopped Carrots	120
		Banana	06
		Sub-total	126
4	Soil Chemistry Section, AARI, Faisalabad	Maize grain	39
5	Vegetable Research Institute, AARI, Faisalabad	Peas	09
6	Nuclear Institute for Agriculture and Biology, Faisalabad	Mung bean	04
7	Director, Regional Agricultural Research Institute, Bahawalpur	Chickpea	4
		Mungbean	3
		Pearl Millet	2
		Sorghum	2
		Oil Seed	2
		Sub-total	13
8	Horticulture Research Institute, Faisalabad	Dates	04
		Kinnow Juice	22
		Fig	06

		Sub-total	32
9	Wheat Research Institute, Faisalabad	Cookies	20
		Wheat Leaf	04
		Sub-total	24
10	Groundnut Research Station, Attock	Groundnut	06
11	Fodder Research Sub-Station, Sargodha	Fodder	08
12	Arid Zone Research Institute, Bhakkar	Mungbean	02
		Grand Total	510

MISCELLANEOUS ACTIVITIES

- An amount of Rs. 868000/- from pilot plant production was deposited into the Government Treasury.
- A 15 days in-house training course was conducted and 52 females were trained.
- 277 ladies; farmers and entrepreneurs have been trained at 08 different places, throughout the Punjab province.
- 23 Radio talks were got recorded for broadcasting.
- Supervised 38 students and internees from different Universities and Colleges throughout Punjab Province.

RUNNING PROJECT DETAIL

One projects (as Team leader)

1. PARB Project No. 914

Title: Development, Optimization and Technology Dissemination of value added products of selected fruits and vegetables

Duration: 2017-2019 (3 years)

Project is initiated to develop stable pulp/juice from selected fruits and vegetables for longer shelf life under ambient conditions through evaluation by physico-chemical characteristics. Three trainings were given to farmers at Gujranwala and sharaqpur regarding pulp preparation from different fruit and vegetables and to preserve for future use to make value added products. They were also informed to which industries they can sell the pulp.

PUBLICATION:

- Ata-Ur-Rehman, Riffat Thaira, Sobia Naheed, Zarina Yasmin, Irrum Babu and Arshad Bahshir. Impact assessment of training on food preservation and processing.2019. JAR, 50 (4):295-300.

- Zarina Yasmin, Naeem khalid, Irrum Babu, Atta-ur-Rehman and Riffat Tahira. 2020. Control of post harvest browing in litchi fruit through organic acids application. J Agric. Res. 58(1):13-19.

- Dr.Tariq Mahmood, Sohail Rashid, Arbab Jahangeer, M.Arshad, Abdul Rahim Khan, Dr. Abdul Majid Shahbaz Mustafa. 2019. Effect of Phosphorous and Potash Fertilizer on Green Fodder and Seed Yield of Berseem (Egyptian clover) under Faisalabad Conditions. IJSBAR
- Irrum Babu, Zarina Yasmin, Rabia Kanwal, Muhammad Asghar and Riffat Tahira. Application of γ- Irradiation and Chitosan Skin Coating for Extension of Storage Life in Mango Fruit. J Agric. Res., 2019, 57(1):45-49.
- Ata-ur-Rehman, Tahira R, Naheed S and Randhawa MA. 2019. Value addition of apple jam with thyme and mint. J. Agric Res., 57(1):39-44.
- Tabussam Tufail, Farhan Saeed, Muhammad Umair Arshad, Muhammad Afzaal, Rizwan Rasheed, Huma Bader Ul Ain, Muhammad Imran, Muhammad Abrar, Muhammad Adil Farooq, Muhammad Zia Shahid. Exploring the effect of cereal bran cell wall on rheological properties of wheat flour. Accepted in Journal of Food Processing and Preservation.
- Muhammad Adrees, Zahra Saeed Khan, Khalid Hussain, Muhammad Rizwan. 2020. Simultaneous mitigation of cadmium and drought stress in wheat by soil application of iron nano-particles. Chemosphere 238 (2020) 124681.
- Nisar Ahmad, Khalid Hussain, Maryam Sarfraz, Muhammad Abubakar Siddique and Waqar Ahmad. 2020. Total Phenolic contents, ascorbic acid and antioxidant potential of different fruits. PJSIR-10037-2686-SA (accepted for publication).

Seminar/conference attended

- Traffic awareness seminar on 2nd July 2019 in main library AARI.
- One day awareness seminar and walk on “eradication of dengue” on 23rd September 2019 in main library AARI.
- National seminar “Crop management strategies for enhancing farm productivity in Punjab” held on 28-10-2019 at AARI, Faisalabad.

- One day seminar on "Novel plant breeding techniques" in biotechnology department on 11th November 2019.
- Celebration of Kashmir Solidarity Day in seminar hall of main library, AARI.
- Displayed sectional products in one-day pastic-uaf "Stem & IT innovations expo: innovative trends in science, technology, engineering, mathematics (stem) and icts" held on 29th January, 2020 at expo Centre, uaf.
- Displayed sectional products in Pakistan horticulture expo at expo center Lahore in January, 2020.
- Participated in the exhibition at BZU Multan organized by Dunya Mela, Feb 2020.

TRAININGS ATTENDED:

- Training of Institutional focal persons regarding AARI website (https://aari.punjab.gov.pk) on 3rd July 2019 in main library AARI.
- 26th Training course on "Advanced analytical techniques for food safety measures in Pakistan" NIAB, Faisalabad from 7th to 11th November 2019.
- Attended 02 days training regarding ISO/IEC 17025:2017 held on 11.12.2019 to 12.12.2019 at Lahore.
- Four weeks training on Finance, Administration, Management and E-Governance from ORIC, UAF
- Two days training course on ISO/IEC 17025:2017at Faisalabad.

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