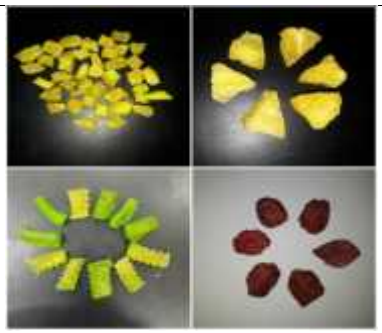
Post-Harvest Research Centre Faisalabad



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OVER VIEW

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.

POST HARVEST RESEACH CENTRE

Physiological response of okra to 1-MCP (1-Methyl Cyclopropane) and modified atmosphere packaging (MAP)

Okra was harvested at mature stage from the Vegetable Research Institute, AARI. After manual grading and sorting, okra was treated with 1-MCP (5 µL/L 1-MCP at 20^0C for 16 hours), then vegetable was packed in 0.03 mm thick perforated polyethylene bags. Okra was stored at ambient conditions and in cold store at 7^0C± 1^0C and 80-85% Relative Humidity. 20 days storage life was observed in okra stored at 7^0C, treated with 1-MCP and packed in MAP. Fig: 1a, 1b.

fig 1a: okra stored without treatment

fig 1b: effect of 1-MCP+MAP

Effect of hot water treatment on papaya post harvest quality and enzyme activity during low temperature storage

Papaya fruit at color break stage were procured from the orchard. After manual sorting the fruit were immersed in hot water at 55±1 ^{0}C for 3, 6 and 9 mins. Immediately after the HWT the fruit were cooled at 25 ^{0}C within 20 min and stored at 12˚C±1˚C with 85-90% relative humidity. Data regarding weight loss %, decay on skin, firmness, pH, TSS, acidity, and color were noted after 5 days interval. Papaya immersed in Hot water at 55±1 ^{0}C for 6 minutes showed best quality result as no spots were observed on the surface of fruit and fruit retained its marketing quality upto 21 days. Fig: 2a, 2b.

fig: 2a: hot water treatment of papaya

fig 2b: papaya after 21 days of storage

Standardization of protocol for raisins production

Grapes of promising variety (Sundar khani and Gola) were harvested at the stage when TSS value reaches to approximately 20^o. After grading and washing with tap water, blanching and sulphiting was done and the fruit was dipped in ethyl oleate (2%, 1.5%) solution and potassium carbonate (4%, 2.5%) solution for 3 minutes. Water/ solution were drained, treated grapes were air dried and then dehydrated up to > 12% moisture content in dryer at 55^0C. Raisin thus obtained was packed in low density polyethylene bags and stored at ambient temperature. The raisins prepared by blanching followed by dipping in Ethyl oleate (1.5%) and K_2CO_3 (2.5% for 3min)

maintained the quality and skin color upto 6 months. Fig: 3a, 3b.

fig 3a: dehydration of grapes

fig 3b: raisin development

The effects of salicylic acid and cinnamon oil application on postharvest quality of peach during storage

Peach fruits were harvested at physiologically mature stage from a commercial orchard. After sorting the fruit was dipped in the solution of Salicylic Acid (1 and 2 mM), cinnamon oil (250 and 500 ppm) for 5 min at 25ºC. All the fruits were stored at 5˚C±1˚C with 85-90% relative humidity for acceptable period. Peach fruit treated with 2 mM Salicylic Acid and 250 ppm cinnamon oil observed better during storage in maintaining quality upto acceptable level for 28 days. Fig: 4a, 4b.

fig 4a: pretreatment of peach

fig 4b: storage of peach

Standardization of post harvest protocol for fig fruit

The fig fruit were harvested on the basis of change in skin color. After washing with antifungal i.e 200ppm sodium hypochlorite solution and drying, figs were subjected to hot water treatment, wax coating and modified atmospheric packing (MAP). Then fruit were stored at ambient and in cold chambers at 1±1°C with 95% RH. Fig fruits stored in MAP created by polyethylene retained their acceptable freshness up to 42 days followed by fruits treated with hot water at 40^{o}C. However, fruit stored at ambient conditions was deteriorated after 3 days.

Impact of modified atmospheric packaging on shelf life of fresh cut bitter gourd

A change in lifestyle patterns has increased demand of fresh cut vegetables. Bitter gourd of good quality and uniform size at mature stage was harvested from the Vegetable Research Institute Fsd. After harvesting bitter gourd was stored at 8 ±1^{0}C for 2 hrs before processing. Bitter gourd was sliced 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, cut vegetable was packed into different packaging material and stored at 8˚C±0.5˚C and 90-95% relative humidity for acceptable period. 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. Fig: 5a, 5b.

fig:5a: pretreatment of bittergourd

fig: 5b: LDPE packing of bittergourd

Effect of edible coating on quality retention and shelf life of cold stored cucumber

Cucumber (promising variety) was harvested from the vegetable Research Institute Fsd. After manual grading and sorting cucumber was washed with 150 ppm sodium hypochlorite solution. Fruit was dipped in coating solutions (chitosan and aloe vera) and then air dried at ambient temperature. Fruits were stored at 10±1°C with 90% RH. Cucumber treated with Chitosan 1% and Aloe Vera Gel 1% showed the best results and storage stability upto 24 days. Fig: 6a, 6b.

fig: 6a: pretreatment of cucumber

fig: 6b: wax preparation

Effect of low temperature conditioning on the storage quality of pear fruit (*pyrus communis)*

This study was planned to investigate the potential of low temperature conditioning (LTC) to inhibit peel browning and to extend shelf life of pear fruit. After harvesting the fruits were given a low temperature conditioning (LTC) at 8˚C for 1, 3, 6, and 9 days respectively and stored at 0˚C ±1˚C for acceptable period.

fig:7: condition of pear after 40 days

Physico-chemical data illustrated that pear fruit kept at 8 ^{0}C for 6 days remained best upto a storage period of 42 days. Fig: 7.

Application of antioxidants to improve post-harvest life of guava fruit

Uniform firm Guava fruits (gola/sofaida variety) at breaker stage were harvested from the orchard. After grading and sorting, fruit was washed thoroughly with chlorinated water and subjected to of three different antioxidant chemicals treatments (ascorbic acid (500 and 1000 ppm), benzyl adenine (25 and 50 ppm) and sodium benzoate (500 and 1000 ppm)). The fruits were then dipped into 0.1 % tween as adhesive for 30 minutes, dried and packed in 300 guage polyethylene bags with 0.1 % ventilation. Fruit was kept at ambient

conditions as well as stored at $8^0C \pm 2^0C$ with 85-90% RH for further studies. Benzyl adenine @ 50ppm was most effective in maintaining shelf of guava fruit upto 15 days.

FOOD TECHNOLOGY

Development and standardization of kinnow juice concentrates through vacuum concentration technique

Kinnow fruit juice was extracted through juice extractor. The obtained fruit juice was thoroughly filtered with fine muslin cloth. Different juice concentrates was prepared (25%, 35% and 45%) by utilizing the vacuum concentration technique. Sodium Benzoate 0.1% and Potassium sorbate 0.02% will be added as preservative. The developed samples will be hot filled in PET bottles and stored at ambient conditions to evaluate the quality parameters during storage. Sensory evaluation of kinnow juice concentrate with 25% brix showed maximum acceptability. Fig: 8a, 8b.

fig: 8a: kinnow concentrate

fig: 8b: juice concentrator

Development and standardization of fruit cocktail

Fruits were purchased from the local market and cleaned with 150 ppm sodium hypochlorite solution. After peeling fruits were diced in approximately 1-3 cm of size. Blanching and sulphiting was done to inactivate the fruit's enzymes. Heat the fruit in the sugar syrup of different concentrations for 2 to 3 minutes. Ascorbic acid 500mg/kg, Sodium Benzoate 400mg/kg, Potassium Sorbate 200mg/kg and Citric acid (0.2%) was added as preservatives. Jars were hot filled with fruit dices and sugar syrup, leaving ½ inch headspace. Jars were placed at ambient conditions to observe the physicochemical and organoleptic properties. The medium sugar syrup (30%) performed well during storage and maintained the quality of fruit chunks. Fig: 9.

fig: 9: cocktail preserved in syrups

Kiwi fruit value addition/processed products with non-nutritive sweetener

This project was designed to develop value added products i.e squash, jam and ready to serve beverage of kiwi fruit according to the product specification with non-nutritive sweeteners (sucrose, Acesulfame K, aspartame) and to study the shelf life of kiwi fruit products during storage. Sensory and physico-chemical analysis showed the acceptability of all samples. No adverse

flavor and taste was observed in all the samples during storage. Fig: 10a, 10b, 10c.

fig: 10a: kiwi jam

fig: 10b: kiwi drink

fig: 10c: kiwi squash

Development and optimization of therapeutic herbal turmeric drink

Fresh turmeric (Curcuma longa) and spices (cardamom and fennel seeds) was procured from local market. After washing and peeling the extract of turmeric and spices was prepared. The filtered extract of both commodities was mixed through blending machine. Pasteurization was done after adding sugar, preservatives, color and Vit. C @ 0.1% of the drink.

fig: 11: therapeutic turmeric drink

The brix of each treatment was maintained approximately at 12.0 and filled in glass bottles. The samples so obtained were stored at ambient temperature. The physico-chemical results showed that the treatment with 60 percent of turmeric extract was found best. Fig: 11

Production and quality assessment of karonda- sweet orange functional RTS beverage

fig:12: karonda-sweet orange drink

Value added functional beverage was prepared by utilizing karonda and sweet orange juice in different combinations. The treatments were designed by using different ratios of karonda and sweet orange juice. The juice was extracted from both the fruit, mixed together through high speed blending machine. Pasteurization was done after adding sugar, preservative and all other ingredients. Drink was hot filled in PET bottles of 300ml capacity. The ready to serve Karonda-Orange functional drink so prepared was stored at ambient temperature. The physico-chemical results showed that the treatment with 70:30 of Karonda-orange juices was found best. Fig: 12.

Development and storage study of pomegranate–pineapple RTS drink

Pomegranate and Pineapple drink was prepared by varying the percentage of fruit juices. After standardization the prepared

drink was hot filled in PET bottles of 300 ml capacityand stored at ambient condition. The physico-chemical analysis and organoleptic evaluation showed that the treatment with 70:30 of pomegranate juice: pineapple juice was found the best. Fig: 13.

fig:13: pomegranate-pineapple RTS drink

Medicinal value addition of apple jam

Apple jam having Medicinal properties was developed with the addition of thyme, aloe vera and cinnamon in standardized concentrations with respect to organoleptic

fig: 14: diet apple jam

evaluation. Sugar is replaced with the artificial sweetener. Aloe vera concentration of 40%, 0.50% thyme and 2.50% cinnamon were ranked at the top for organoleptic evaluation.

Development of Dietetic Bael- Peach Jam

Bael fruit and peach was procured locally. After washing, peeling and de stoning the fruits, pulp of fruits was prepared. The diet jam was prepared by using low caloric sweetener sorbitol. The physico-chemical analysis of all the treatments was carried out after one-month storage interval as well as the samples was evaluated organoleptically. The results showed that the diet jam prepared with 80% bael pulp and 20%peach pulp ranked best as compared to other treatment having bael and peach pulp with ratio 100:0, 90:0, 70:30 and 60:40. Fig: 15.

fig:15: bael peach jam

Development and optimization of avocado value added products

Fresh avocado fruit of varieties California long, Ceylon blue and Murree Gola was harvested from Hill Fruit Research Station, Sunny Bank, Murree. After washing, sorting and destoning pulp was extracted with the help of pulper. Avocado jam and sauce was prepared by following standard formula from pulp of different varieties. Cooking heating was carried out till the jam gets brix 68^{o} to 70^{o} and sauce up to 40^{o} brix. The samples so prepared were filled in jars and stored at ambient temperature for further studies. Jam prepared with ratio of avocado: apple 60:40 and avocado sauce with ratio of 50:50 avocado: apple ranked best organoleptically. Fig: 16a, 16b.

fig:16a: avocado jam

Fig: 16b: avocado sauce

BIOCHEMISTRY SECTION

Nutritional quality evaluation of varieties/ lines of kharif fodders

Representative plant samples of maize, sorghum and pearl millet fodder were collected from Fodder Research Institute, Sargodha for their nutritional quality evaluation. Results revealed that variety of maize Ag-2002 produced maximum crude protein (14.4%). In Pearl Millet fodder crude protein (10.2%) was found higher in Tift-383 line. While in Sorghum fodder crude protein (8.73%) was found higher in Advanced line V6.

Nutritional quality evaluation of different grapes varieties

Sample of seven varieties of grapes i.e. Superior, Sultanina C, Danlas, Vitro black, Kings ruby, Flame seedless and Priest were collected from Barani Agriculture Research Institute, Chakwal and analyzed for Ascorbic acid, Tartaric acid, Total phenols, Beta carotene, TSS, Sugars, Copper, Iron and manganese. TSS (17.5%,) Non reducing sugar (8.85%) and Iron (125.16 ppm) were found maximum in Flame Seedless while Vitamin C (3.68 mg/100g) and Copper (15.9 ppm) were found higher in Sultanina C. Highest reducing sugar (13.3%) and manganese (27.7 ppm) were found in Kings Ruby. Overall, variety Sultanina C performed better due to its higher vitamin C (3.68 mg/100g) and variety Priest due to its higher total sugars (17.6%). Fig: 17.

Fig: 17: grapes varieties priest & sultania c

Chemical composition of Aloe vera with respect to seasonal variation

Samples of Aloe vera were collected after every three months, starting from July 2018. Fresh plant leaves were used to determine gel %, and fresh gel were used to record pH, vitamin C and TSS. Plant leaves were dried and analyzed for dry matter, crude protein, crude fat, ash, crude fiber, NFE, zinc and iron. Gel percentage (65.03%), pH (4.47), crude protein (14.6%) and TSS (1.74%) were observed in samples collected during summer (July to September, 2018) while gel percentage (63.74%), pH (4.81), TSS (0.80) and crude protein (15.4%) were observed in the samples collected during winter (Oct. to Dec, 2018). Overall, seasonal variation had non-significant effect on gel percentage and chemical composition of aloe vera, however gel percentage slightly higher in summer as compared to winter. Fig: 18.

Fig: 18: aloe vera gel

Nutritional evaluation of Moringa (*Moringa olifera*) leaves and its comparison with other conventional fodders

It is reported that Moringa leaves are being used as fodder for animals. The experiment was conducted to compare the nutritional value of two Moringa varieties (PK-1 Indian and Pakistan Sufaid Seed) with other conventional fodder (Maize, Sorghum and Pearl millet).

Fig: 19a: moringa plant

Sufaid seed contains high crude protein (31.9%) and dry matter (30.03%) as compared to moringa variety PK-1 Indian which contains less crude protein (29.4%) and dry matter (29.2%). Moringa leaves from the both varieties contained high content of protein and dry matter as compared to other conventional fodders. Crude Protein and dry matter in sorghum was 8.19% and 23.8%, in maize fodder 12.8% and 19.3% and in pearl millet fodder 9.29% and 17.7% respectively. Fig: 19a, 19b.

Fig: 19b: moringa seed

Effect of phosphorus on nutritional quality and yield of wheat

A field experiment was conducted to see the effect of phosphorus on nutritional quality and yield of wheat. Experiment comprised of four doses of phosphorus 60, 80, 100 and 120 kg ha^{-1}. Results revealed that Phosphorus application @ 120 kg ha^{-1} along with NP produced maximum grain yield (4.48 t ha^{-1}), ash (0.94 %), crude protein (10.8 %), phosphorus (0.38 %) and potassium (0.36 %).

Cooking effect on nutritional quality of vegetables

In an experiment, four winter vegetables carrot, cauliflower, pea and turnip were analyzed for crude protein, crude fat, ash, crude fiber and NFE before and after boiling for 20, 40 and 20 minutes Indian cooking. It is concluded that cooking had no deteriorating effect on quality parameters like ash content, crude fat, crude fiber and NFE while protein contents decreased with increasing boiling time in all four vegetables. Crude protein in carrot decreased from 5.99% in fresh to 2.23% after Indian cooking, in peas it decreased

from 16.0% in fresh to 8.37% after Indian cooking and crude protein in turnip decreased from 7.13% in fresh to 2.53% after Indian cooking

Effect of different biostimulant in the quality of rice and wheat

In a pot experiment, six biostimulants, rely, BM plus, fertigrain, sea maxx, hook and asari star were applied to wheat and rice crop. At maturity grian samples were collected and analyzed for moisture, crude fat, crude protein, ash, crude fiber and NFE. Results revealed that no significant improvement observed in quality due to stimulant application, however, application of BM plus biostimulant showed maximum crude fat (1.52%), crude protein (7.81%) and ash content (1.28%) in rice. BM plus also gave the comparatively higher values of ash content (1.12%), crude protein (13.1%) and crude fat (1.17%) in wheat.

Quality comparison of carrot and sweet pea grown in specific areas with those grown in scattered areas of Faisalabad

Various villages of Shahkot are being considered as hub for growing carrot. It is the view point of farmers that the carrots of these areas are of good quality. Carrot samples were collected from hub area as well as the villages away from the hub area. Proximate analysis showed that there was no significant difference in biochemical composition of carrot, collected from hub area (Shahkot) with the carrot collected from areas away from the hub. Carrot from hub areas contained crude protein from 6.6 to 7.8%, ash from 5.1 to 7.7%, crude fiber 4.6 to 6.8% and NFE from 78.9 to 81.8%. While, the carrot sampled from areas away from hub contained crude protein from 5.5 to 7%, ash from 5.02 to 7.7%, crude fiber 4.2 to 6.7% and NFE from 80.2 to 83.5%.

Evaluation of nutritional difference in vegetables grown in tunnels (off season) and field condition (on season)

Eighteen samples of cucumber off season (grown in tunnels) and 18 samples of cucumber on season (grown in field) were collected from farmers' tunnels and fields respectively. Proximate analysis of samples collected from tunnels and field showed no significant difference in their chemical composition. Moisture, NFE and crude fat in cucumber samples collected from tunnel and fields were 95.6 and 94%, 91.3 and 89.9% and 0.68 and 0.5% respectively. Fig: 20.

Fig:20: cucumber in tunnels

Assessment of antioxidant and nutritional potential of different fruits and vegetables

Samples of four fruits (kiwi fruit, pineapple, sweet lemon, kuranda) and four vegetables

(arvi, broccoli, sweet potato and sugar beet) were collected from local market for assessment of their antioxidant and nutritional potential. Analysis of fruit samples showed that higher percentage of TSS (15.6%), beta carotene (125 µg/100 mL) and total phenols (1225 mg GAE/mL) were observed in kuranda, while total antioxidants (87.8 mg GAE/mL) and vitamin C (50 mg/100 mL) in sweet lemon. Regarding vegetables results revealed that maximum crude fat (5.97%), crude fiber (10.97%), crude protein (9.8%) and ash (8.75%) were observed in Broccoli compared to other vegetables while minimum value of crude fat (3.6%), crude fiber (6.5%) and crude protein (4.9%) were found in Arvi. Among tested fruits, sweet lemon proved best having high antioxidant potential (87.8 mg GAE/mL). Among vegetables sweet potato has high antioxidant potential (81 mg GAE/mL).

Differential response of mung bean genotypes towards nutritional quality due to microbial inoculation

A field trial in collaboration with Pulses Research Institute, Faisalabad was conducted to check the response of microbial inoculation on nutritional quality on six mung bean varieties/lines (15003, 14005, 15005, 08009, AZRI 2006 and NM-2016). Results revealed that the varieties respond differently due to microbial inoculation. However, microbial inoculation produced higher protein as compared to un-inoculation. Maximum crude protein (25.35 %) and crude fat (1.35 %) was observed in line No. 14005 with inoculation. Maximum crude fiber (5.15 %) was observed in line no. 08009 inoculated, while maximum ash (4.04 %) was observed in AZRI 2006 with inoculation.

Evaluation of nutritional status of different rabi and kharif fodders

Rabi (lucerne, berseem, oat, rye grass) and kharif (Sorghum, Maize, pearl millet, rhode grass) fodders were collected from fodder research sub-institute, AARI, Faisalabad during rabi and kharif season for evaluation of nutritional status. As far as analysis of rabi fodders are concerned protein contents were found maximum in Lucerne (22.25%) while crude fat (1.92%) and crude fiber (26.42%) values were high in oat, lowest protein was found in oat (7.95%). Among the values of kharif fodders crude protein (12.75%) and crude fat (2.94%) was found high in rhode grass while pearl millet contains maximum crude fiber (31.85%). Lowest crude protein was found in pearl millet (7.83%).

Effect of climate change during growth period of wheat on its flour quality

A field experiment was conducted to assess the effect of sowing time on the quality of wheat grain. Nine sowing times were selected for this purpose. Wheat variety galaxy was sown on 01-Nov,10-Nov,20-Nov,01-Dec,10-Dec,20-Dec,01-Jan,10-Jan and 20-Jan 2018. Results revealed that sowing time did not significantly affect the chemical composition of wheat grain. Crude

fat ranged from 1.08 to 1.14%, crude protein 11.80 to 12.36%, crude fiber 0.85 to 0.95% in grain samples collected from wheat crop sown during November to January.

MISCELLANEOUS ACTIVITIES

- An amount of Rs. 908704/- from pilot plant production was deposited into the Government Treasury.
- A 21 days in-house training course was conducted and 14 females were trained.
- 279 ladies; farmers and entrepreneurs have been trained at 09 different places, throughout the Punjab province.
- 14 Radio talks were got recorded for broadcasting.
- Supervised 135 students and internees from different Universities and Colleges throughout Punjab Province.
- A total of 360 samples (maize fodder, oat, berseem, alfalfa, guar, maize grain, brinjal, sugar cane, chickpea, wheat grain, turnip, spinach, lentil, radish) received from different institutes/sections were analyzed for quality parameters i.e. dry matter, crude protein, crude fat, crude fiber, NFE, antioxidants, phenols, beta carotene, sugars, vitamin C and mineral matter.

Running project detail

Two projects (as Team leader)

1. PARB Project No. 904

Title: Nutrition enhancement of crops, fruits, vegetables and their products under climate change scenario

Duration: 2017-2022 (5 years)

Project is initiated to address the issue of malnutrition in human by bio-fortification of various crops and fruits. This section analyzed 41 types of citrus (163 samples), 169 samples of mango, 9 samples of wheat grain, 25 samples of pearl millet, 50 samples of rice, 112 samples of mung bean, 15 samples of chick pea and 15 samples of canola.

2. 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. Meetings with farmers/ progressive growers for storage and preservation of pulp were conducted. 30 samples of carrot, guava, tomato, strawberry were analyzed for beta carotene and total phenolic contents and data was compiled. Seminar was arranged on the use of color meter CHROMA-400.

Publication:

- Abrar,M., H.Shair, S.shamim and A.Javed. 2018. Nutritional assesment and storage stability of groundnut oil cookies. J. Agri. Res. 56(2): 123-129.
- Abrar, M., Din, M. Zubair and M. Musa. 2018. Sutability of recent winter bread wheat varieties for

bakery products. J. Agric. Res. 56(2): 123-129.

- Mann, A.A, A.Nazir, M.K.I.Khan, T. Ahmad, R. Zia, M.Mund and M. Abrar.2018. the therapeutic properties and applications of aloe vera: A review. J. Herbal Medicine. 12:1-10.
- 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.
- Tahira R, Rehan T, Ata-ur-Rehman and Jamal A. 2018. Seasonal disparity in total phenols, flavonoids, antioxidant and antimicrobial activity of Lemongrass (Cymbopogancitratus) cultivated in Islamabad, Pakistan. Journal of Agricultural Research, 56(2): 87-93.
- 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.
- Kausar H., Parveen S. Aziz M.M. , Saeed S. 2018. Production of carrot pomace powder and its utilization in development of wheat flour cookies. J.Agric.Res. 56(1):49-56.
- Din, A , Chughati, M.F. J Khan, M.R.K. Shahzad.A Khaliq, A. Nasir M.A. Nutrition and Functional perspective of Barley B-Glucan. International Food Research Journal. 25(5):1773-1784.
- Naseem Akhtar, Muhammad Naveed, Muhammad Khalid, Nisar Ahmad, Muhammad Rizwan and Saima Siddique. 2018. Effect of bacterial consortia on growth and yield of maize grown in Fusarium infested soil. Soil and Environment. 37(1): 35-44.
- Nisar Ahmad, Maryam Sarfraz, Khalid Hussain, Naseem Akhtar, Waqar Ahmad, Muhammad Abu Bakar Siddique. 2018. Quality comparison of some local varieties of apples grown at Murree, Punjab, Pakistan. Int. J. Agron. Agric. Res. 13(5): 89-95.

Urdu Articles

- عبد الرحیم خان، ارم یابو۔ پھلوں اور سبزیوں کی اندرون و بیرون ملک مارکیٹنگ کے جدید تقاضے۔ یکم تا ۱۵ جنوری ۲۰۱۹ء، پندرہ روزہ زراعت نامہ، **58(1)20.**
- ڈاکٹر احمد دین، کوارنٹین کی کرشماتی اہمیت۔ یکم تا ۱۵ جنوری ۲۰۱۹ء، پندرہ روزہ زراعت نامہ، **58(1)22.**
- ارم یابو، عبد الرحیم خان، رابعہ کنول۔ سبزیوں کی غذائی اہمیت۔ یکم تا ۱۵ نومبر ۲۰۱۸ء، **57(21)21.**
- ارم یابو، عبد الرحیم خان، زرینہ یاسمین۔۔ سبزیوں کی غذائی اہمیت ۔۱۵تا۳۱ جولائی ۲۰۱۸۔ پندرہ روزہ زراعت نامہ، **57(14)22.**

- ڈاکٹر احمد دین, ڈاکٹر محمد ابرار۔ کوارلنڈل کی انسانی صحت کے لیے طبی اہمیت اور افادیت۔۱۵تا۳۰ ستمبر ۲۰۱۸۔ پندرہ روزہ زراعت نامہ،22(18)57-

Seminar/conference attended

- Seminar on "weed eradication" on 06-08-18 in AARI Auditorium
- Attended one day workshop for capacity building of young scientists on "Communicating Science to Society" at AARI on 5th October, 2018.
- One day conference on "role of plant genetics resources in varietal development and seed system" arranged by PARC in main library hall, AARI.
- "Training session on the usage of color meter CHROMA-400 under PARB Project-914.

Trainings attended:

- Attended "one day Hands on training for statistical data analysis" on 18th September 2018 in committee room of DGR, AARI.
- Two day traning workshop on "Emerging Technologies in Research Advanced Ms-office and Digital Resources" on 24th September, 2018 in main library, AARI.
- Five days training on information technology skills at MPDD, Lahore.
- One day training workshop on capacity building of young scientists on communicating science to society
- International Training Program"Food Security: Post Harvest, Processing And Quality Assurance of Selected Agro-Industrial Products" under TICA, Ministry of Foreign affairs of Thailand.

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