Summary and Conclusion
5.0. Summary and Conclusion:

Health consciousness and concerns for safer foods are on the increase. Also, environmental consciousness has increased. As a result people have started preferring eco-friendly products and practices. All these issues have raised a gradual demand for sustainable development in agricultural field. Organic agriculture is one of the sustainable agriculture methods as organic agricultural practices are based on natural way to improve soil quality such as cover crop, crop rotation, manure, mulching etc. Interest in organically produced food is increasing throughout the world in response to the concerns about intensive agricultural practices and their potential effect on both human health and the environment.

Organic farming is a production system which avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators. The use of genetic engineering, sewage sludge and irradiation are prohibited in organic production and processing. It aims to enhance biodiversity, genetic diversity and soil biological activity to achieve an optimal natural system, which aims at attaining social, ecological and economic sustainability. Organic foods are produced by organic agriculture practices. As discussed in review, a type of agricultural method affects nutritional quality, sensory attributes and safety aspects of any crops. Hence, the present investigation was planned with the following objectives:

- To evaluate nutritional value of organic and conventional foods
- To study non-nutritive bioactive compounds in organic and conventional foods
- To compare Pesticide residue level in organic and conventional foods
- To evaluate sensory attributes of organic and conventional foods
- To collect information on availability, types, producers, retailers, and consumers of organic foods
- To study the consumer perception and knowledge regarding the organic foods

To fulfill these objectives various research activities were carried out and the result obtained for each activity is summarised as follow:
Research Activity -I: Comparison of nutritional and non-nutritive bioactive compounds in organic and conventional foods.

Nutrients and non-nutritive bioactive components are affected by many factors involved in the cultivation practices. Hence, this part of the study focuses on the comparison of the nutrients and non-nutritive bioactive compound of two different cultivation practices i.e. organic and conventional. Green leafy vegetables, roots and tubers, other vegetables, fruits, cereals, pulses, split pulses, spices and condiments and miscellaneous food commodities were analysed for various nutrients and bioactive compounds. The samples of organic foods were purchased from organic farm. Moisture, ash, calcium, iron, phosphorus, ascorbic acid, β-carotene, protein, fat and total phenol, flavonoid and total antioxidant capacity were analysed from both the selected organic and conventional food samples.

Total twenty six organic and conventional vegetables were studied which comprise of seven leafy vegetables, roots and tubers, gourds and other vegetables.

**Moisture** content in organic leafy vegetables ranged from 84.49 gm% to 93.07 gm% whereas in conventionally grown leafy vegetables, it ranged 88.28 gm% to 94.88 gm%. Except coriander leaves, all the leafy vegetables significantly (p<0.01) varied in their moisture content while comparing cultivation practices. Moisture content of organic roots and tubers ranged from 81.13 gm% to 94.47 gm% and in conventional roots and tubers it varied from 76.67 gm% to 95.44 gm%. A significant difference was noticed in potato, radish, turmeric and mango ginger. Among other vegetables, moisture content of organic vegetables ranged from 77.52 gm% to 94.30 gm%. While in conventional vegetables it ranged from 80.85 gm% to 94.99 gm%. Brinjal, drumstick and green chillies showed significant difference in moisture content with respect to cultivation practices. Moisture content of organically grown gourds varied from 85.00 gm% to 96.30 gm% and in conventionally grown gourds it ranged from 83.66 gm% to 96.07 gm%. A significant difference was observed in sponge gourd, bitter gourd and ivy gourd.

**Ash** content ranged from 1.32 gm% to 3.94 gm% among organically grown vegetables, while in conventional leafy vegetables it ranged from 1.25 gm% to 3.63 gm%. Except,
spinach all the organic leafy vegetables contained higher ash contents. However, a significant difference was noticed for amaranth leaves, fenugreek leaves, coriander leaves, mint leaves and radish leaves. The ash content of organically roots and tubers ranged from 0.71 gm% to 4.30 gm% while it ranged from 0.41 gm% to 4.95 gm% among conventionally grown roots and tubers. A significant difference was observed for all the studied roots and tubers except beet root. Among other vegetables, ash content of organic vegetables showed range of 0.31 gm% to 2.27 gm% while ash content of conventional vegetables varied from 0.57 gm% to 1.87 gm%. A significant difference was observed in brinjal, drumstick, okra, Indian beans, cowpea and cluster beans. Ash content of organically grown gourd ranged from 0.39gm% to 0.52 gm% while among conventional gourds it ranged from 0.30 gm% to 0.49 gm%. Except pointed gourd, none of the gourds showed any significant difference while comparing agricultural practices.

**Calcium** content of organic leafy vegetables varied from 109.26mg% to 507.14mg% and in conventional leafy vegetable it ranged from: 73.68 mg% to 505.78 mg%. Except fenugreek leaves and spinach, all leafy vegetables showed significant difference in calcium content. Organically and conventionally grown roots and tubers showed a range of 21.12mg% to 89.10 mg% and 14.32 mg% to 60.10 mg% respectively. A significant difference was noticed for all the studied roots and tubers. Among other vegetables, organic vegetables showed a range of 24.66 mg% to 187.52 mg% while conventional vegetables showed a range of 14.32 mg% to 126.14 mg%. Drumstick, green chillies, cauliflower, okra, Indian beans, cowpea and cluster beans significantly varied for their calcium content when comparing the effect of organic and conventional farming systems. The highest calcium content among organic gourds was 56.19 mg% while the lowest calcium content was 46.68 mg%. Among conventional gourds, it ranged from 28.19 mg% to 43.50 mg%. Organically and conventionally grown sponge gourd, pointed gourd and ivy gourd showed significant difference in calcium content.

**Iron** content ranged from 0.20 mg% to 18.26% among organic leafy vegetables while it ranged from 0.13 mg% to 12.62 mg% among conventionally grown leafy vegetables. Organic colocasia leaves amaranth leaves and spinach showed significantly (p<0.01) higher iron content than their conventional counterparts. For organic roots and tubers, it
ranged from 0.46 mg% to 6.12 mg%, while in conventional roots and tubers it ranged from 0.40 mg% to 4.67 mg%. A significant difference was observed for potato, turmeric and beetroot. Among other vegetables, iron content of organic and conventional vegetables varied from 0.23 mg% to 5.27 mg% and 0.18 mg% to 5.12 mg% respectively. A significant difference was noticed in brinjal, drumstick, cauliflower, okra and cowpea. Moreover, among gourds, it ranged from 0.18 mg% to 6.09 mg% for organic gourds while in conventional gourds it ranged from 0.18 mg% to 4.59 mg%. A significant difference was noticed in pointed gourd and ivy gourd.

**Phosphorus** content ranged from 35.11 mg% to 73.11 mg% and 22.47 mg% to 75.74 mg% in organically and conventionally grown leafy vegetables respectively. A significant difference was noticed for spinach, coriander leaves, colocasia leaves. Organic and conventional roots and tubers showed a range of 35.94 mg% to 125.79 mg% and 21.74 mg% to 161.81 mg% respectively. All the roots and tubers showed significant difference in phosphorus content pertaining to agricultural practices. For other vegetables, phosphorus content of organic vegetables varied from 20.10 mg% to 191.75 mg% and it varied from 27.82 mg% to 239.84 mg% in conventional vegetables. A significant difference was noticed in brinjal, drumstick, tomato, cauliflower and green chillies. Among gourds, phosphorus content was found in a range of 24.59 mg% to 76.63 mg% and 14.33 mg% to 69.57 mg% in organic and conventional gourds respectively. A significant difference was noticed in all the gourds except ivy gourd.

**Ascorbic acid** content was varied from 13.73 mg% to 141.03 mg% among organic leafy vegetables. While among conventional leafy vegetables it ranged from 23.20 mg% to 93.30 mg%. A significant difference was noticed for ascorbic acid between all the organic and conventional leafy vegetables except mint leave. Organic and conventional roots and tubers showed a range of ascorbic acid from 4.17 mg% to 63.06 mg% and 5.22 mg% to 48.07 mg% respectively. Except onion and radish, all the studied roots and tubers showed significant difference in their ascorbic acid content. Among other vegetables, it ranged from 6.34 mg% to 119.99 mg% in organic vegetables and in conventional vegetables it ranged from 6.07 mg% to 105.12 mg%. Brinjal, green chillies and Indian beans showed significant difference in ascorbic acid content with respect to farming.
practice. Organic gourds, ascorbic acid content ranged from 14.55 mg% to 60.09 mg% and in conventional gourds, it ranged from 12.07 mg% to 47.82 mg%. Sponge gourd, bitter gourd and pointed gourd showed significant difference in ascorbic acid while comparing agricultural practices.

Among organically grown leafy vegetables, β-carotene content varied from 2010.97 μg% to 12255.40 μg% and among conventionally grown leafy vegetables it ranged from 1495.64 μg% to 11210.96 μg%. A significant difference was observed in amaranth leaves, fenugreek leaves, coriander leaves, spinach and mint leaves. Among other vegetables, green chillies, Indian beans and cluster beans were detected with β-carotene and all three vegetables from organic origin showed higher content of β-carotene than their conventional counterparts. Among gourds, bitter gourd and pointed gourd were detected with β-carotene content. Both the gourds showed significant (p<0.05) difference in β-carotene content while comparing agricultural methods.

Total phenol content ranged from 109.71 mgGAE/100g to 431.94 mgGAE/100g and 119.91 mgGAE/100g to 391.03 mgGAE/100g in organic and conventional leafy vegetable respectively. Fenugreek leaves, mint leaves, colocasia leaves, amaranth leaves and spinach showed a significant difference in total phenol content with respect to agricultural practices. Among roots, total phenol content of organic and conventional roots and tubers ranged from 29.81 mgGAE/100g to 708.06 mgGAE/100g and 25.62 mgGAE/100g to 469.31 mgGAE/100g respectively. All the organic roots and tubers showed significant higher total phenol content except radish in comparison with conventional ones. Among other vegetables, total phenol content varied from 64.88 mgGAE/100g to 194.05 mgGAE/100g and 32.44 mgGAE/100g to 119.99 mgGAE/100g in organic and conventional vegetables respectively. Except Indian beans, all the organic vegetables showed higher total phenol content as compared to conventional ones. Total phenol content of organic gourds varied from 55.70 mgGAE/100g to 115.76 mgGAE/100g whereas in conventional gourds it ranged from 38.24 mgGAE/100g to 129.50 mgGAE/100g. Except bitter gourd, all three gourds varied for total phenol content while comparing the agricultural methods.
The range for flavonoid content in organic leafy vegetable was 79.02 mgRE/100g to 217.10 mgRE/100g and in conventional leafy vegetable it ranged from 75.99 mgRE/100g to 179.68 mgRE/100g. A significant difference was observed for amaranth leaves, colocasia leaves, mint leaves and fenugreek leaves. Flavonoid content of organic roots and tubers ranged from 13.15 mgRE/100g to 94.43 mgRE/100g and in conventional roots and tubers, it ranged from 9.24 mgRE/100g to 63.46 mgRE/100g. All the roots and tubers except mango ginger showed significant higher flavonoid content than their conventional counterparts. Among other vegetables, flavonoid content of organic vegetables was varied from 11.93 mgRE/100g to 51.51 mgRE/100g and in conventional vegetables, it ranged from 9.96 mgRE/100g to 41.75 mgRE/100g. Except drumstick, all the organic vegetables showed significant higher flavonoid content as compared to their conventional counterparts. Flavonoid content of organic and conventional gourds ranged from 6.33 mgRE/100g to 37.67 mgRE/100g and 4.52 mgRE/100g to 55.04 mgRE/100g respectively. Organically grown sponge gourd and bitter gourd showed significant higher flavonoid content as compared to conventional ones.

A significant difference for DPPHRSA was observed for all the organically and conventionally leafy vegetables. Among organic and conventional leafy vegetables it ranged from 80.20 mgGAE/100g to 459.68 mgGAE/100g and 42.35 mgGAE/100g to 285.27 mgGAE/100g respectively. For organic roots and tubers, DPPHRSA ranged from 31.60 mgGAE/100g to 91.63 mgGAE/100g while for conventional roots and tubers it ranged from 33.81 mgGAE/100g to 77.78 mgGAE/100g. A significant difference was observed in radish, turmeric and beetroot. Among other vegetables, DPPHRSA of organic and conventional vegetables ranged from 24.15 mgGAE/100g to 93.38 mgGAE/100g and 17.04 mgGAE/100g to 83.61 mgGAE/100g respectively. Except drumstick and cauliflower, all the organically grown vegetables showed significant higher total antioxidant capacity in comparison with conventionally grown vegetables. Organic gourds showed a range for DPPHRSA from 28.84 mgGAE/100g to 78.50 mgGAE/100g and for conventional it ranged from 29.47 mgGAE/100g to 65.29 mgGAE/100g. Organic pointed gourd and ivy gourd showed significant higher values for DPPHRSA as compared to conventional ones.
Organically and conventionally grown fruits namely raw mango, ripe mango, guava, banana, lemon, amla, custard apple, papaya and jamun were studied for nutrient and antioxidant parameters.

**Moisture** content of organic fruits ranged from 71.30 gm% to 90.33 gm% and it ranged 72.08 gm% to 92.97 gm% in conventionally grown fruits. Except banana and custard apple, no other fruit showed significant difference for moisture content while comparing cultivation practices. Organic fruits showed a range for **Ash** content from 0.46 gm% to 0.98 gm% and in conventional fruits, it ranged from 0.70 gm% to 0.92 gm%. A significant difference was noticed with respect to raw mango, ripe mango, guava, banana and jamun for ash content pertaining to agricultural practices.

**Calcium** content of organic and conventional fruits varied from 60.69 mg% to 79.72 mg% and 12.93 mg% to 66.57 mg% respectively. Except mango and amla, all fruits showed significant difference in calcium content. **Iron** content ranged from 0.52 mg% to 15.69 mg% among organic fruits while it ranged from 0.26 mg% to 12.32 mg% among conventionally grown fruits. Iron content of organic raw mango, lemon, papaya and jamun was found significantly (p<0.01) different as compared to their conventional counterparts. Organically grown fruits showed a range of **Phosphorus** from 10.23 mg% to 63.10 mg% and among conventionally grown fruits it ranged from 10.37 mg% to 47.77 mg%. Sapota, lemon, guava, custard apple, banana, papaya and jamun from organic cultivation varied significantly for their phosphorus content in comparison with the conventional ones.

**Ascorbic acid** content varied from 22.25 mg% to 738.11 mg% among organic fruits. While among conventional fruits, it ranged from 12.02 mg% to 567.56 mg%. A significant difference was noticed for ascorbic acid between organic and conventional sapota, amla, lemon, guava and banana. **β-carotene** content was detected in raw mango, ripe mango and papaya. It ranged from 98.75 µg% to 3521.20 µg% and 67.67 µg% to 2790.34 µg% in organic and conventional fruits respectively. Raw mango and papaya significantly varied in their carotene content as the cultivation practices vary.
Total phenol content ranged from 39.89 mgGAE/100g to 6778.39 mgGAE/100g and 38.23 mgGAE/100g to 4092.53 mgGAE/100g in organic and conventional fruits respectively. A significant difference for total phenol content was noticed in raw mango, ripe mango, sapota, amla, lemon and jamun. The range for flavonoid content in organic fruits was 21.89 mgRE/100g to 291.64 mgRE/100g and in conventional fruits, it ranged from 12.41 mgRE/100g to 177.16 mgRE/100g. A significant difference was observed for raw mango, ripe mango, amla, lemon, banana and jamun. DPPHRSA ranged from 45.46 mgGAE/100g to 764.70 mgGAE/100g among organic fruits and from 35.90 mgGAE/100g to 620.41 mgGAE/100g among conventional fruits. A significant difference was noticed in all the fruits except lemon.

Organically and conventionally grown cereals namely wheat, rice, maize, pear millet, finger millet, sorghum and amaranth seeds were studied for nutrients and non-nutritive bioactive compounds.

Organically grown cereals showed a range for moisture content from 12.30 gm% to 15.44 gm% and in conventionally grown grains, it ranged from 12.97 gm% to 16.97 gm%. A significant difference was noticed for tukdi wheat and finger millet. Ash content ranged from 0.67 gm% to 2.72 gm% and 0.69 gm% to 2.60 gm% among organically and conventionally grown cereals respectively. Wheat (tukdi and bhalia) and sorghum showed a significant difference for ash content while comparing cultivation practices.

A range for protein content for organic and conventional cereals 6.84 gm% to 14.91 gm% and 7.09 gm% to 15.55 gm% respectively. Except basmati rice, none of the cereal showed any significant difference for protein content. Moreover, except finger millet, all the organic cereals showed lower protein content as compared to their conventional counterparts. Fat content of organic cereals ranged from 0.35 gm% to 5.60 gm% while it ranged from 0.57 gm% to 5.54 gm% among conventional cereals. Rice (Gujarat-17) and pearl millet showed significant difference in fat content with reference to agricultural methods.

Calcium content of organic and conventional cereals varied from 15.56 mg% to 411.97 mg% and 10.62 mg% to 361.66 mg% respectively. A significant difference in calcium
content was noticed between organic and conventional wheat (tukdi and bhalia), rice (Gujarat-17 and basmati) and finger millet. A range for Iron content was found 0.93 mg% to 10.85% among organic cereals while it ranged from 0.83 mg% to 7.61 mg% among conventionally grown cereals. Except wheat (tukdi and bhalia), none of the organic cereals significantly (p<0.01) differed for iron content as compared to their conventional counterparts. Phosphorus content ranged from 103.09 mg% to 314.36 mg% and 148.09 mg% to 349.5 mg% in organic and conventional cereals. Wheat (tukdi and bhalia), rice (Gujarat-17 and basmati) and finger millet showed a significant difference for iron content when the cultivation practices were compared.

A range for total phenol content was found from 76.81 mgGAE/100g to 850.81 mgGAE/100g and 65.26 mgGAE/100g to 677.31 mgGAE/100g in organic and conventional cereals respectively. A significant difference was noticed for rice (Krishna kamod), pearl millet, finger millet and amaranth seeds. The flavonoid content in organic cereals ranged from 10.93 mgRE/100g to 125.72 mgRE/100g and in conventional cereals, it ranged from 6.31 mgRE/100g to 141.07 mgRE/100g. Except sorghum, all the organic cereals significantly differed for flavonoid content as compared to their conventional counterparts. Among organic and conventional cereals, DPPHRSA ranged from 37.91 mgGAE/100g to 117.25 mgGAE/100g and 32.15 mgGAE/100g to 92.73 mgGAE/100g respectively. A significant difference was noticed for wheat (tukdi), maize, pearl millet and finger millet when agricultural methods were matched.

Total seventeen organically and conventionally grown pulses and split pulses were studied for nutrients and bioactive compounds.

The range of moisture content of organic and conventional pulses was from 7.91 gm% to 14.07 gm% and 8.69 gm% to 14.79 gm%. The moisture content of organic split pulses varied from 10.75 gm% to 13.94 gm% and among conventional split pulses it ranged from 10.90 gm% to 14.25 gm%. A significantly (p<0.01) difference was noticed for Bengal gram (local), soyabean and peas among pulses and in Bengal gram splits and red gram splits among split pulses while comparing cultivation practices. Ash content ranged from 1.30 gm% to 4.89 gm% among organically grown pulses, while in conventional
pulses, it ranged from 1.91 gm% to 4.74 gm%. In organic and conventional split pulses, ash content ranged from 2.02 gm% to 3.89 gm% and 2.01 gm% to 3.78 gm% respectively. A significant difference was noticed for Bengal gram (local and kabuli) moth and black gram among pulses and Bengal gram splits; black gram splits (with and without husk) among split pulses.

**Protein** content for organic and conventional pulses ranged from 15.46 gm% to 41.13 gm% and 18.45 gm% to 45.94 gm% respectively. Among organic split pulses it ranged from 18.28 gm% to 26.44 gm% and in conventional split pulses, it varied from 20.30 gm% to 20.63 gm%. A significant difference for protein content was observed in all the pulses except Bengal gram (kabuli), peas and lentil and among split pulses, Bengal gram splits, red gram splits, black gram splits (with and without husk) pertaining to organic and conventional agriculture methods. Organic pulses showed a range for **Fat** content from 1.56 gm% to 22.12 gm% while it ranged from 0.72 gm% to 20.78 gm% among conventional pulses. In organic and conventional split pulses, it ranged from 1.38 gm% to 7.82 gm% and 1.10 gm% to 5.64 gm% respectively. Except Bengal gram (local), all the organic pulses showed significant difference in fat content as compared to their conventional counterparts. All the split pulses except black gram splits (without husk) showed a significant difference was noticed for fat content.

**A range for Calcium** content in organic pulses was 56.11 mg% to 347.22 mg% and in conventional pulses it ranged from 55.41 mg% to 336.10 mg%. Organic and conventional split pulses showed a range for calcium content: from 58.89 mg% to 163.89 mg% and from 57.45 mg% to 132.22 mg% respectively. Except kidney bean (red) and lentil, all pulses showed significant difference in calcium content. All organic split pulses, except Bengal gram splits showed significant different amount of calcium than their conventional counterparts. **Iron** content of organic pulses ranged from 4.32 mg% to 16.66 mg% while it ranged from 4.23 mg% to 18.92 mg% among conventionally grown pulses. For split pulses, it ranged from 4.34 mg% to 8.45 mg% and 4.34 mg% to 7.25 mg% for organic and conventional origins. Iron content showed a significant difference for all the pulses while among split pulses, significant difference was noticed in black gram splits (with and without husk) and lentils. **Phosphorus** content ranged from 242.33
mg% to 633.69 mg% and 235.23 mg% to 291.37 mg% in organically and conventionally grown pulses respectively. It varied from 260.34 mg% to 428.75 mg% and 260.64 mg% to 419.85 mg% in organically and conventionally grown split pulses respectively. Among pulses, green gram, Bengal gram (local and kabuli), mothbeans, kidney beans (red) and lentil showed significant difference for phosphorus content. For split pulses, a significant difference was noticed for black gram splits (without husk) and lentil splits while comparing the cultivation practices.

**Total phenol** content ranged from 66.80 mgGAE/100g to 636.22 mgGAE/100g and 53.70 mgGAE/100g to 506.17 mgGAE/100g in organic and conventional pulses respectively. Among organic split pulses total phenol content varied from 71.29 mgGAE/100g to 245.88 mgGAE/100g and it varied from 51.27 mgGAE/100g to 208.64 mgGAE/100g among conventional split pulses. Except black gram, all the organic pulses showed higher total phenol content. A significant difference was noticed for green gram, Bengal gram (kabuli), soybean, black gram, kidney bean (red), peas and lentil. Among split pulses, except Bengal gram splits (with and without husk), all the organic split pulses significantly varied for total phenol content with their conventional counterparts.

The range for **flavonoid** content in organic pulses was 13.28 mgRE/100g to 233.47 mgRE/100g and in conventional pulses it ranged from 13.28 mgRE/100g to 233.47 mgRE/100g. Organic and conventional split pulses showed a range for flavonoid content from 14.51 mgRE/100g to 75.19 mgRE/100g and 15.95 mgRE/100g to 52.86 mgRE/100g respectively. A significant difference was observed for green gram, Bengal gram (local), soybean, kidneybean (chitra), peas and lentil. Moreover, among split pulses, a significant difference was observed for all the split pulses except Bengalgram splits and lentil splits. **DPPHRSA** ranged from 79.72 mgGAE/100g to 435.25 mgGAE/100g for organic pulses and 71.71 mgGAE/100g to 411.21 mgGAE/100g for conventional pulses. While among organic and conventional split pulses, it varied from 72.72 mgGAE/100g to 89.51 mgGAE/100g and 82.99 mgGAE/100g to 87.18 mgGAE/100g respectively. A significant difference was observed for green gram, soyabean, kidney bean (red), peas and lentil. Moreover, red gram splits, green gram splits (with and without husk), black gram splits (without husk) showed significant difference in DPPHRSA pertaining to agricultural methods.
Among organically and conventionally grown spices and condiments, a range for total phenol content was observed from 129.23 mgGAE/100g to 5039.09 mgGAE/100g and 113.63 mgGAE/100g to 2957.04 mgGAE/100g respectively. All the organic spices and condiments showed higher total phenol content as compared to conventional ones. However, coriander powder, clove, cardamom, cinnamon and black pepper showed a significant difference in total phenol content with respect to agricultural practices. The range for flavonoid content in organic spices and condiments was 114.33 mgRE/100g to 2289.58 mgRE/100g and in conventional spices and condiments, it ranged from 49.29 mgRE/100g 1516.66 mgRE/100g. All the organic spices and condiments except cumin and cinnamon showed significantly different contents of flavonoid as compared to their conventional counterparts. DPPHRSA ranged from 314.36 mgGAE/100g to 2177.55 mgGAE/100g and 119.29 mgGAE/100g to 1821.60 mgGAE/100g among organic and conventional spices and condiments respectively. All the organic spices and condiments showed significant higher value for DPPHRSA as compared to conventional spices and condiments.

Among miscellaneous food commodities, organic jaggery showed significant higher content of ash, calcium, iron and flavonoid while lower content of moisture and phosphorus than conventional jaggery. Organic honey showed significant higher content of moisture, iron, total phenol and flavonoids in comparison with conventional ones. While phosphorus content was found significantly lower in organic honey. Organic and conventional sesame seed significantly differed for moisture, ash, iron, total phenol and flavonoid contents. For groundnut, ash, calcium, iron, total phenol and flavonoid significant varied while comparing organic and conventional methods. Results for green tea indicated that organic green tea showed significant higher values of total phenol, flavonoid and DPPHRSA.

**Research Activity -II: Comparison of pesticide residue level in organic and conventional foods.**

A total of 52 pesticides, 20 organochlorine, 17 organophosphates and 7 synthetic pyrethroids and 7 herbicide residues were analysed using Gas Chromatography Selected
fruits and vegetables namely amla, lemon, mango, sapota, Indian beans, green chillies, spinach, fenugreek leaves, cauliflower and brinjal and among cereals and pluses, wheat, rice, green gram and red gram splits were studied as samples.

From the results obtained for pesticide residues, it was noticed that organically grown Indian beans were found contaminated with γ-HCH. Organic green chillies were also found contaminated with one residue i.e. pp’-DDD. Among conventional vegetables, Indian beans were found to be contaminated with the residues of α- endosulphan, β-endosulphan, endo-sulphates and chlorpyriphos. Green chillies were contaminated with the residues of α- endosulphan, β- endosulphan, endo-sulphates, chlorpyriphos, profenophos and ethion. Spinach was contaminated with the residues of fenvalarate- I and II, deltamethrin-I and II. Okra contained L-cyhalothrin residues. No other vegetables from organic and conventional found to be contaminated with pesticide residues. As compared to organic vegetables, more conventionally grown vegetables were contaminated with various OC/SP and OP residues. However none of the organic and/or conventional vegetable sample exceeded MRL. Among fruits, conventional amla was found to be contaminated with residues of α- endosulphan, β- endosulphan, endo-sulphates while conventional lemon was contaminated with Me- parathion residues. However, these residues were found far below than MRL. All the organically grown fruits as well as conventionally grown mango and sapota did not show the contamination with any pesticide residues. In cereals and pulses, conventionally grown green gram (whole) was contaminated with fenvalerate- I and II. No pesticide residues were detected in organic and conventional grains and pulses namely wheat, rice and red gram splits.

15.38 % of total studied organic foods were contaminated with OC/SP residues while none of the organic foods were contaminated with OP. Similarly, 46.15 % and 30.77% of conventionally grown foods found to be contaminated with OC/SP and OP residues respectively.

Overall, 15.38 % of total studied organic foods were contaminated with OC/SP residues while none of the organic foods were contaminated with OP. Similarly, 46.15 % and 30.77% of conventionally grown foods found to be contaminated with OC/SP and OP residues respectively.
residues respectively. This reveals that organically grown foods have lower and lesser residual level of pesticides than the conventional foods. Comparing vegetables from both types of agriculture systems, conventionally grown vegetables were found to be contaminated with multiple pesticide residues; however the pesticide residue levels are far below than MRL. Hence it may be considered that vegetables grown in Central Gujarat from both the cultivation practices could be quite safe for consumption.

Research Activity -III: Sensory evaluation of organic and conventional foods.

Sensory attributes are the important criteria for the purchase of foods. As discussed in review, it was noticed that farming method can affect the sensory properties of crop. In the present study, sensory attributes of organically and conventionally grown foods were evaluated. The composite scoring test was used as sensory score card. In cereals and pulses, appearance, cooked flavour, cooked texture, taste were analysed while in fruits and vegetables, the sensory attributes like colour, shine, uniformity, absence of defect, flavour and taste were studied.

Among 34 fruits and vegetables samples, the score for colour was noticed significantly (p<0.05) higher for 17 organic samples. Organically grown green leafy vegetables as well as some coloured vegetables like beet root, fresh turmeric, capsicum, cowpea, cluster beans significantly differed in colour score as compared to their conventional counterparts. Similarly organically grown mango (ripe) and papaya showed significant (p<0.01) higher scores for colour. However, 16 samples did not show any significant difference pertaining to colour score. Six samples of organic fruits and vegetables namely ripe mango, jamun, potato, tomato, brinjal and sponge gourd and five conventional samples namely onion, turmeric, okra, ivy gourd and cluster beans showed significant (p<0.05) higher scores for shine as compared to their counterparts. 23 fruit and vegetable samples did not differ in sensory score for shine. Similarly, majority of the sample did not vary for sensory score pertaining to uniformity. About 26 samples did not show any significant difference pertaining to absence of defect. 11 organic samples (ripe mango, papaya, guava, custard apple, amla, amaranth leaves, spinach, potato, radish, beetroot and tomato) and one conventional sample namely fenugreek leaves showed significantly
(p<0.05) higher score for texture. While 22 samples did not significantly differ in the sensory score related to texture. Out of 34 fruit and vegetable samples, 25 samples did not vary for the sensory score for taste. Five organic samples (ripe mango, custard apple, spinach, coriander leaves and radish) got higher scores for flavour as compared to conventional ones by sensory panel. The remaining samples did not significantly differ for flavour. Organically grown ripe mango, banana, coriander leaves, mint leaves, radish, beetroot, drumstick, cauliflower and cowpea showed significant higher scores for taste as compared to conventional ones while the remaining 25 sample did not differ for taste as per the scores given by sensory panel members.

Among cereals, the score with regards appearance was noticed significant (p<0.05) higher for organic finger millet and for flavour it was observed higher for conventional pearl millet as compared to counterparts. No significant difference was observed in sensory attributes for any other cereals when as compared the agricultural practices. Among pulses and split pulses, organic black gram splits showed significant higher scores for appearance as compared to conventional black gram splits with husk. Conventionally grown kidney bean (chitra) showed significant (p<0.05) higher scores for flavour and overall acceptability. Overall, out of 24 cereals, pulses and split pulses, 2 organic samples showed significant (p<0.05) higher scores for appearance, 2 conventional samples showed significant (p<0.05) higher score for flavour whereas one conventional sample showed significant higher scores for overall acceptability. No significant difference was observed in any of the cereals, pulses and split pulse samples pertaining to texture and taste.

Research activity-IV: Information on availability, types, producers, retailers and consumers of organic foods in Gujarat.

To collect the information about organic farming and organic food available in Gujarat, NGOs like “Srishti” and “Jatan” were approached as well as traditional food fair namely “Satvik” was visited at the beginning of the study. Biennial convention organized by OFAI was also attended. In “Satvik”, the information about the farmers engaged in organic farming with their produce as well as organic food retailers from different parts of Gujarat was
collected. In OFAI Biennial convention, the information regarding organic farming, total number of farmers engaged with organic farming in Gujarat was collected.

As per collected information, there are about 150-175 organic farms in Gujarat. There are around twenty organic food stores in Gujarat mainly located in four major cities of Gujarat namely Anand, Ahmedabad, Vadodara, Rajkot, Surat and also in Bharuch, Nadiad, Vallabh Vidyanagar, Navsari, Valsad, Bhavnagar, Bhuj and Mandavi. (However the number of organic food stores to date may vary from this reported number). The different food commodities sold at the farm, farmer’s outlet, organic food stores and malls are mainly plant based foods and other herbal products. Food commodities like cereals, pulses, seasonal fruits & vegetables, nuts, honey, jaggery, oils, ghee, green tea, spices and condiments and various semi processed products such as rice flakes, puffed rice, rice papad, ragi papad, pickles, roasted grains, fruit powders, etc. A few processed products are also available like pickles, chutneys, juices, khakhra etc. The numbers of consumers at particularly organic farm or store vary as per the location of the store or farm.

**Research activity-V: Attitude and practices followed by organic farmers about organic farming**

A questionnaire was also designed to collect farmer’s information about the knowledge and practices regarding organic farming. The self-developed questionnaire was sent to 75 organic farmers in the different regions of Gujarat. The response rate of the questionnaire was 57.33%.

In surveyed farmers engaged in organic farming, although 54% farmers had switched to organic farming after years of conventional farming, majority of the farmers were practicing farming without use of chemical fertilizers and pesticides. The opinions about the organic farming were similar that organic food are tastier, safer and having better quality. More than 50% of farmers were aware of various National and International certifications regarding organic farming but about 72% have not applied for organic certification as they found it as an expensive issue. As per farmers’ opinion government should take an initiative to promote organic farming and organic foods in the society.
The average duration when the respondent farmers initiated organic farming is 12.93 years and about 72 % of the farmers are practising organic farming in 100% of their land area. Before converting their farms to organic farms, they kept 3 to 4 years of wash off period for soil which was satisfying the resting time period of soil i.e. 3 years as per one of the criteria for organic certification. In the organic farming, various natural and bio-fertilizers like cow dung, vermicompost, plant waste, castor oil seed cakes were used to maintain soil fertility as well as crop rotation and mulching of soil was also done to enhance the fertility of soil by the studied farmers. To protect crop, various natural components like cow urine, the upper layer of buttermilk, boiled extracts of plants, self-prepared bio pesticide as well as bio pesticide available in market were used. All the farmers used water from bore wells and stored rain water for the farming purpose. They managed the seeds for the farming by themselves by storing them. In the farmers’ opinion, no special technology is needed as they were using the traditional farming practices using farm animals. About 35% of farmers said that they get more production and less wastage for their crops. The requirement of labours in the farm varied according to season and type of crop. The main crops as per the study were wheat, rice, pearl millet, corn, Bengal gram, green gram, seasonal fruits and vegetables, sugarcane, spices and condiments as well as cotton and fodder.

Research Activity-VI: Consumer survey regarding knowledge, attitude and purchasing behaviour of organic and conventional foods.

The survey was carried out in four major cities in Gujarat namely Ahmedabad, Vadodara, Rajkot and Surat. A total of 900 consumers were surveyed for their knowledge, attitudes and purchasing behaviour about organic foods. From that 450 were organic food consumers and 450 were non consumers of organic foods. The questionnaire has four different sections namely demographic details, awareness about organic foods, attitude regarding organic food and purchasing behaviour for organic foods.

Among the respondents, 55 % were males and 45 % were female. From the various aspects of socioeconomic profile of the respondents, educational qualification, occupation, marital status and family income showed significant (p<0.05) association
with the consumption of organic foods. Out of 450 non-consumers, about 62 % of the respondents were aware of organic foods and 38% of the respondents did not have any awareness regarding organic foods. Majority of the respondents in both the groups were aware through the word of mouth from friends/relatives. Printed and audio-visual media was also observed for spreading awareness of organic foods. About the interpretation, majority of the respondents mentioned that organic foods are grown without pesticides and chemical fertilizers and many of them considered organic food as natural and fresh foods. A very few respondents were aware that organic food are non-genetically modified. About 50% of the organic food consumers and about 6% of non-consumers were aware about organic certification such as NPOP, Eco-cert, Indo-cert etc. Majority of the respondents from both the groups have mentioned that Government should take an initiative to promote organic farming and organic foods.

Total 23 statements related to attitudes towards organic foods were analysed through factor analysis. After statistical analysis, total five factors namely quality and trust, health and environment consciousness, cost and acceptability concerns, identification and availability of organic foods and importance of organic certification were derived. These factors significantly affected the overall attitude score regarding organic foods.

About the purchasing behaviour of the respondents, 450 were organic food buyers whereas out of 450 non consumers of organic foods, 60% were willing to buy organic foods. Majority of the organic consumer purchase it for the various reasons. Most prominent reason was safety aspect of organic followed by better quality, freshness, healthier, tastier and Lastly eco-friendly nature. Similarly, various reasons for not purchasing organic food were also mentioned by non-consumers group. Two main reasons were insufficient information and unavailability issues. Moreover, lack of variety, unpleasant appearance, need of organic certification mark, dislike for taste, don’t no difference in nutritional quality and lack of trust in organic foods were other reasons for not purchasing organic foods. However, price premium was not an issue for non-consumer group for purchasing organic food.
Majority of the organic consumers were purchasing organic food at least once/month followed by weekly buyers. Majority of the buyers (37.6%) spend Rs. 500/- to Rs. 1,000/- per month and the purchasing ratio of 40:60 (organic: conventional) was preferred by majority of the organic consumers. Rice (especially basmati and Krishna-kamod), wheat, millets, pulses (especially green gram), seasonal vegetables and fruits (especially mangoes, papaya and sapota), honey, jaggery, groundnuts, sesame seed oil, cow’s ghee and spices were the commonly purchased food commodities by organic consumers.

Conclusion:

In recent time, food containing phytochemicals with functional properties along with safety are in great demand in food and pharmaceuticals sectors. Organic foods are believed to be safer and to have better quality. In this context, the present study has evaluated nutrient and non-nutritive bioactive compounds from organic and conventional foods. Ash, calcium, iron, fat, ascorbic acid and β-carotene contents were found higher in organically grown foods. Higher concentration of polyphenol, flavonoid and free radical scavenging activity against DPPH were also observed in organically grown foods. From this perspective, it can be concluded that inclusion of organic foods in daily diet could be a better alternative in maintaining good health as they serve higher levels of specific micronutrients and antioxidants.

From the pesticide residue analysis, it was noticed that very few organically grown foods were found to be contaminated with pesticide residues as compared to conventional ones. Although, more conventional food commodities were found to be contaminated with various pesticide residues, majority of the pesticides were found far below MRL in conventionally grown samples collected from the region of Anand and Ahmedabad. Hence, it may be considered that studied fruits, vegetables, cereals and pulses grown in Central Gujarat from both the cultivation practices could be quite safe for consumption.

From the result obtained for the sensory attributes of organic and conventional foods has revealed that majority of the organic and conventional samples did not significantly vary in sensory attributes. It can be interpreted that selected organically grown foods have
better colour, texture and taste. Conclusively, the organic foods are equally acceptable as conventional ones.

Information related to availability of organic foods in Gujarat state, it was observed that organic foods are available easily in metro cities of Gujarat. However, in other cities and towns, very few stores, supermarkets and farm outlets are selling organic foods. Hence the availability of organic foods could be considered as one of the important criteria for policy makers.

The result obtained from survey of organic farmers it was observed that majority of the farmers were doing organic farming in 100% of their agricultural land area. Organic farmers were using various bio pesticides and bio fertilizers. Although the farmers have awareness regarding organic certifications and practicing farming without use of agrochemicals for many years, neither of them have certified organic farms nor have they applied for any organic certification.

The results of consumer survey revealed that the level of awareness about organic food was good but clear perception regarding organic food was not observed. Quality and trust, health and environment consciousness were important criteria for selecting organic foods. Cost was not a factor obstructing in selection of organic foods. Hence, this information about consumers' knowledge, attitude and purchasing behaviour in Gujarat can be useful to policy makers in organic farming at regional level.

Conclusively, plant foods grown with organic cultivation practices and also with conventional agricultural method in the study area could be quite safe for consumption but organically grown foods provide better quality in terms of micronutrients and antioxidant potential along with good sensory acceptance. Organically grown foods fulfill the criteria for overall food quality which comprises nutritional quality, sensory quality and safety aspects which are key drivers for the selecting organic foods among the consumers in Gujarat.