Original Article

Comparison of organic and chemically grown cereals crops in context of antioxidant potential

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Abstract

The multibillion organic industries are fueled by consumer perception that organic food is healthier. Studies of the nutrient content in organic foods vary in results due to differences in the ground cover and maturity of the organic farming operations. Reviews of multiple studies shows that organic varieties do provide significantly greater level of vitamin C, iron, magnesium and phosphorous than nonorganic varieties of the same food. While far fewer studies have been conducted to evaluate a direct relationship between the possibilities of organically grown food to retain a higher percentage of antioxidants in food.

The present study therefore was focused on gaining an empirical evidence whether organic food offer any generic nutritional advantage particularly promoting the vital constituent in food i.e. plant antioxidants. The antioxidant affects of all the extracts from organically and conventionally grown cultivars of Rajma Beans (*Phaseolus vulgaris* L.), *Amaranth* species, Finger Millet (*Eleusine coracana* L.), Prso Millet (*Panicum miliaceum* L.) and Rice (*Oryza sativa* L.) have also been studied for different antioxidant tests like DPPH and Phosphomolybdenum Assay. The flavanoid content, phenolic compound content and ascorbic acid content were also studied. The current investigation unleashed some of the facts associated with the primary and secondary plant metabolites, polyphenols and antioxidants. Extensive field survey provided significant information on some important agriculture practices which are potentially suitable for organic agriculture. The current investigation also reviewed some of constraints which is deterrent for promotion of organic agriculture like ground problems associated with market linkages, process of certification, corporate control of agriculture, niche export market etc, which are instrumented in putting the farmers of small land holding capacity in predicament.

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Introduction

The perception that organic food is better for human health than conventionally grown foods are related to the following broad classes of chemical compounds in plants like nitrogen , metabolites, minerals, heavy metals, vitamins and wide array of phytochemicals, however when it comes to one of the most vital components of food the antioxidants, the picture is blurred. There is tantalizing but inconclusive evidence in the literature that suggests that organic food have the potential to elevate the average antioxidant levels as a consequence of the prohibition of synthetic pesticide imposing stress on plants that tend to trigger plant defenses and it is this, antioxidant driven plant defenses that account for the rich colors and flavors of certain fruits, vegetables and grains. Organic farming systems support relatively higher levels of soil microbial diversity and activity compared to conventional farms.[1]

Since more organic food is entering the mainstream food distribution system and domestic organic market is no longer a niche segment of specific buyers it was therefore considered noteworthy to explore whether organic food system offer generic nutritional advantage, elevating antioxidant levels in food. If so, then it may perhaps be the most significant opportunity to increase average daily antioxidant intake as a part of their daily diets. It was therefore thought worthwhile to explore the determination of antioxidant as a likely driver exerting protection when grown in the defense of pesticides.

Pleothera of studies in the last two decades have in undertaken on nutrient density[2,3,4,5], organoleplic quality[8], the environment[9] and in some cases plant and animal health and food safety[10].

Interest in research on secondary metabolites and antioxidants in organic verses conventional foods has only been underway a few years. There is also a strong evidence that whole grain cereals are good source of vitamins, folates, phenolic acids, zinc, iron, selenium, copper, manganese, carotenoids, phytic acids, lignin, lignans and alkylresorcinols all of which have significant antioxidant potential *in vitro.*[11]

Considering all this, attempts were made to explore the possibilities of evaluating phytochemical profiles and total antioxidants along with the data base of primary and secondary metabolites for coherent appraisal of antioxidants as a promising initiative to provide empirical evidence to explore whether organic food is really worth the cost and effort and more than a lifestyle choice.

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Materials and Methods

Plant materials and extracts

Samples of conventional as well as organically grown seeds of Rajma Beans (*Phaseolus vulgaris* L.), *Amaranth* species, Fingar Millet (*Eleusine coracana* L.), Prso Millet (*Panicum miliaceum* L.) and Rice (*Oryza sativa* L.) were used in the study.

Extract preparation:

Powdered sample of seeds were taken for the extraction procedure. Extracts were prepared with 40 mL of solvent consisting of methanol, 0.16M HCl and water in the ratio of 8:1:1 for 2 hours. The extracts were filtered and residues were extracted again with 40ml of 70% Acetone for 2 hours. The methanol extracts were centrifuged and supernatants were stored at 20°C for evaluation studies.

Estimation of Ascorbic Acid:

The ascorbic acid (AA) concentration was measured by using the 2,6-dichlorophenol-indophenol (DCPIP) photometric method of Guri.[12] 2 mL of methanolic extracts were added in 10 mL of ice-cold 0.0005 mol/L EDTA solution containing 3 % trichloro-acetic acid (TCA) for 1–2 min. The homogenate was quickly filtered through Whatman No.1 filter paper and brought up to 20 mL with EDTA-TCA extracting solution. The reaction mixture contained 1 mL of distilled water, 2mL of DCPIP reagent, and 2mL of filtered extract. The absorbance was measured quickly at 600 nm. The concentration of ascorbic acid was determined from a standard curve that was prepared previously using various known concentrations of ascorbic acid. DCPIP reagent was prepared by dissolving 13 mg of DCPIP and 3 g of reagent grade anhydrous sodium acetate in 1L of distilled water.

Total Phenolic content

The total phenolics were assayed colorimetrically as described by Shahidi and Naczk[13] with few optimized modifications as follows: A 1.5 ml of ten-fold diluted Folin-Ciocalteu's Phenol Reagent, 1.5 ml of 7.5% sodium carbonate and 50 µl methanolic extracts were mixed well in the cuvette. The absorbance was measured at 765 nm after 30 min at room temperature. A mixture of reagents and water was used as a blank. Gallic acid was used as calibration reference standard, and calibration solutions contained 100, 200, 300, 400, 500, and 600 mg/l Gallic acid, diluted from the same Gallic acid stock solution (1g/l). The content of phenolics is expressed as Gallic acid equivalents.

Estimation of Flavanoids

The total flavonoid concentration was measured using a colorimetric assay developed by Zhishen et al.[14] Briefly, 1 mL of methanolic extracts were added to a 10 mL volumetric flask containing 4 mL of ddH_2O. At time zero, 0.3 mL of 5% $NaNO_2$ was added to each volumetric flask; at 5 min, 0.3 mL of 10% $AlCl_3$ was added; at 6 min, 2 mL of 1 M NaOH was added. Each reaction flask was then immediately diluted with 2.4 mL of ddH_2O and mixed. Absorbance of the mixtures upon the development of pink color was determined at 510 nm relative to a prepared blank. The total flavonoid contents of the samples are expressed in milligrams per serving of Quercitine equivalents (QE). All samples were prepared in three replications.

Antioxidant assays

DPPH photometric assay

Each sample stock solution (1.0 mg ml^{-1}) was diluted to final concentrations of 500, 250, 100, 50 and 10 m g ml^{-1}, in methanol. A total of 1 ml of a 0.3 mM DPPH methanol solution was added to 2.5 ml of sample solution of different concentrations and allowed to react at room temperature. After 30 min, the absorbance values were measured at 518 nm and converted into the percentage antioxidant activity using the following equation: scavenging capacity %/ 100/ [(Absorbance of sample/ Absorbance of blank) / 100/ Absorbance of control]. Methanol (1.0 ml) plus plant extract solution (2.5 ml) was used as a blank, while DPPH solution plus ethanol was used as a negative control. The positive controls were DPPH solution plus any 1 mM flavonoid. The SC50 values were calculated by linear regression of plots, where the abscissa represented the concentration of tested plant extracts or flavonoids and the ordinate the average percent of scavenging capacity from three replicates (Braca *et al*., 2001[15]).

Phosphomolybdanum Assay

The total antioxidant capacity of extracts was evaluated by method of Prieto et al.[16] and expressed as equivalents of ascorbic acid (µmol/g of extract).

Result

Evaluation of antioxidant potential in the cultivars of Rajma Beans (*Phaseolus vulgaris* L.), *Amaranth* species, Fingar Millet (*Eleusine coracana* L.), Prso Millet (*Panicum miliaceum* L.) and Rice (*Oryza sativa* L.) was screened in different extracts i.e: Benzene, Ethyl Acetate, Ethanol, Methanol and Water, of which the maximum extraction yield was obtained in methanolic extract. Hence methanolic extract was used for carrying out Ascorbic Acid content, Flavinoid Content, Phenolic Compound content, DPPH Assay and Phosphomolybdenum Antioxidant Capacity Assay.

Figure 1: comparison of DPPH Assay in organic and conventially grown samples of *Oryza sativa* L. extracts.

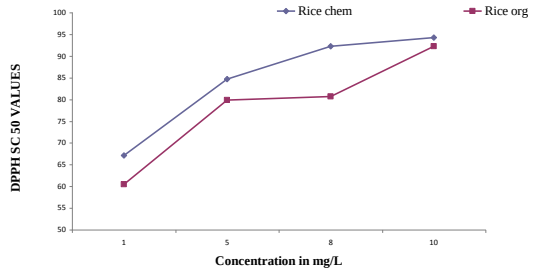


Figure 2: comparison of DPPH Assay in organic and conventially grown samples of *Amaranth sp.* extracts.

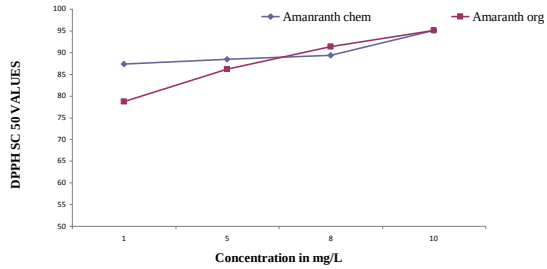


Figure 3: comparison of DPPH Assay in organic and conventially grown samples of *Panicum miliaceum* extracts.

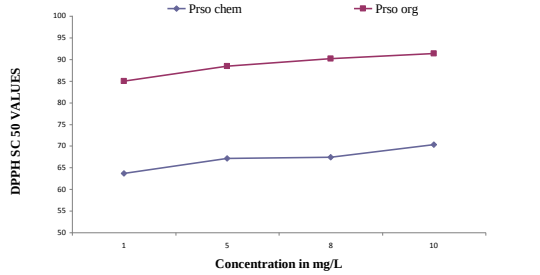
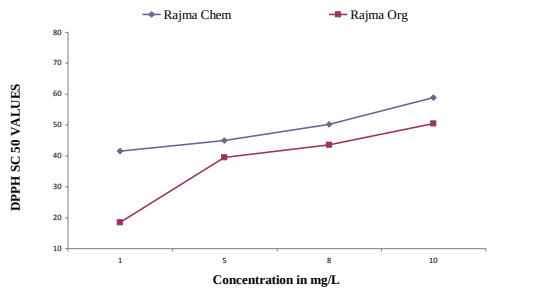
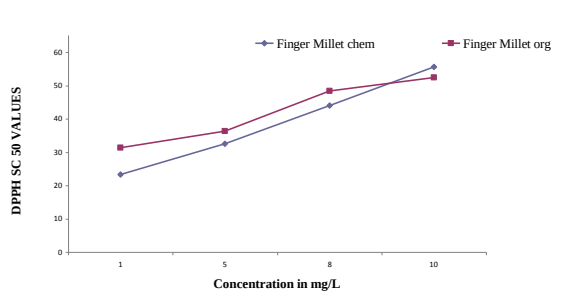


Figure 4: comparison of DPPH Assay in organic and conventially grown samples of *Phaseolus vulgaris L.* extracts.



The results for Scavenging capacity (SC) % of DPPH assay (Figure 1-5) was higher in organically grown Rice followed by Prso Millet (*Panicum miliaceum)* and not much difference in the values of ascorbic acid was noted in the cultivars of Finger-millet and Rajma. However in amaranth the chemically grown cultivar had more ascorbic acid as compared to the organically grown cultivar of amaranth.

Figure 5: comparison of DPPH Assay in organic and conventially grown samples of *Eleusine coracana L.* extracts.



The results of DPPH assay also exhibited significantly higher differences in the Proso Millet (figure) grown organically followed by Rice (figure) corroborating with the results of ascorbic acid. A good range of significantly higher percentage of scavengers in organically raised cultivars were found in prso and rice over conventionally grown corresponding cultivars, however results were relatively less significantly in Finger millet and Rajma. Amaranth showed higher activity in organically as well as conventional grown cultivars.

Highest antioxidant capacity by the Phosphomolybdanum Assay (Figure 6) was achieved in organically grown Amaranth cultivar followed by chemically grown Amaranth. Maximum Flavanoid content (Figure 8) was observed in Finger millet and Rajma, followed by Parso Millet, Rice and Amaranth. Maximum Phenolic Compounds (Figure 7) content was observed was organically grown Rajma cultivars. Significant differences were observed in organically and conventionally grown Finger millet cultivars

Figure 6: Antioxidant capacity (Phosphomolybdnum Assay) method for comparison of conventional as well as organically grown crops.

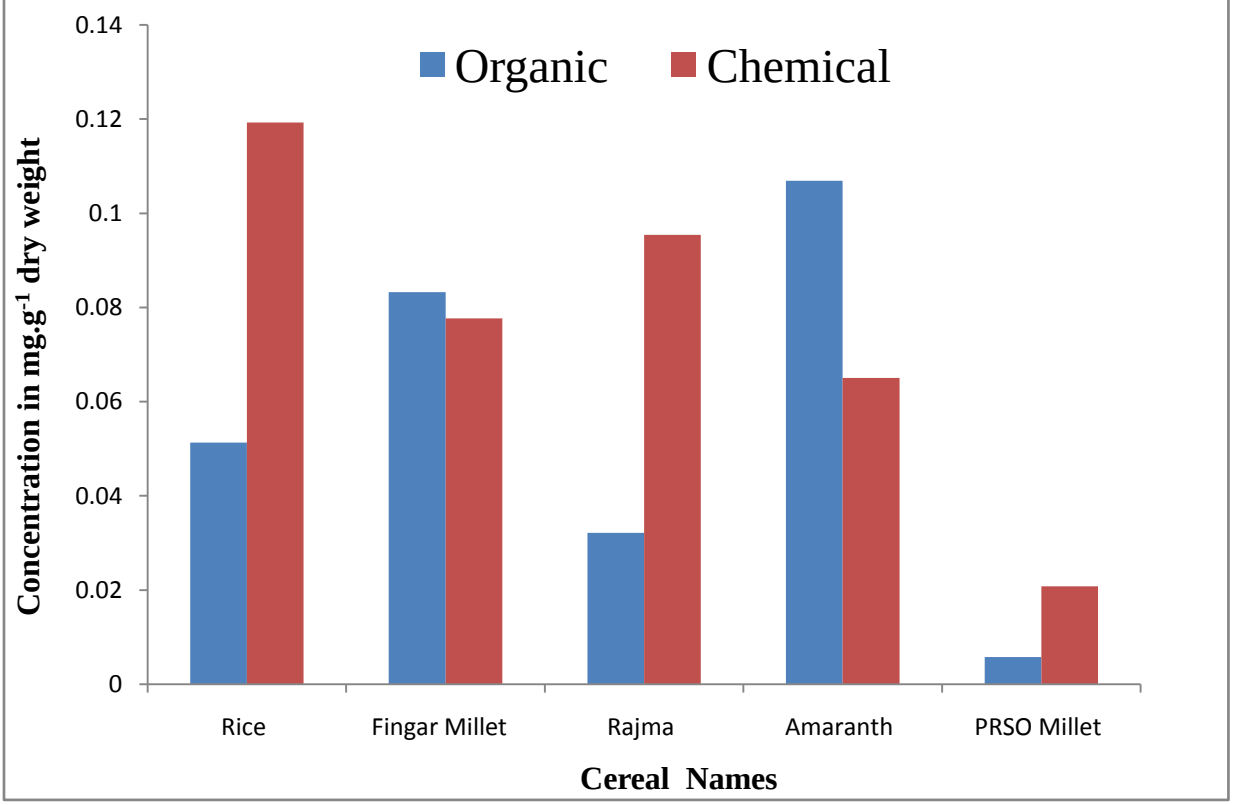


Figure 7: Phenolic compound content in conventional as well as organically grown crops.

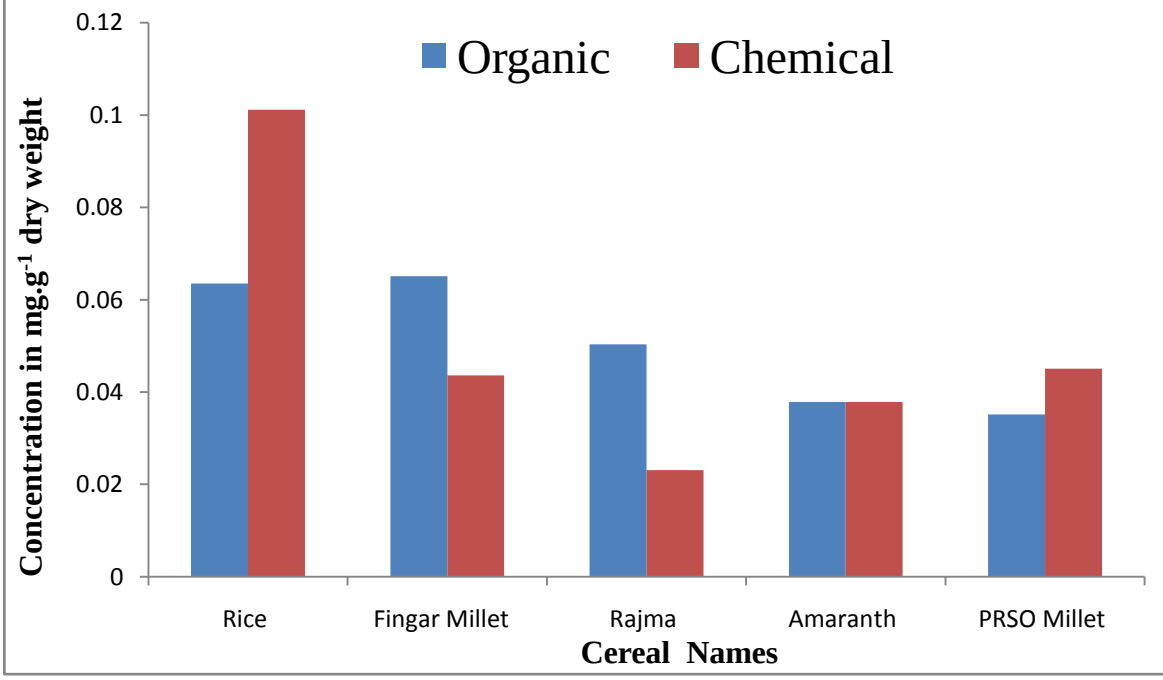
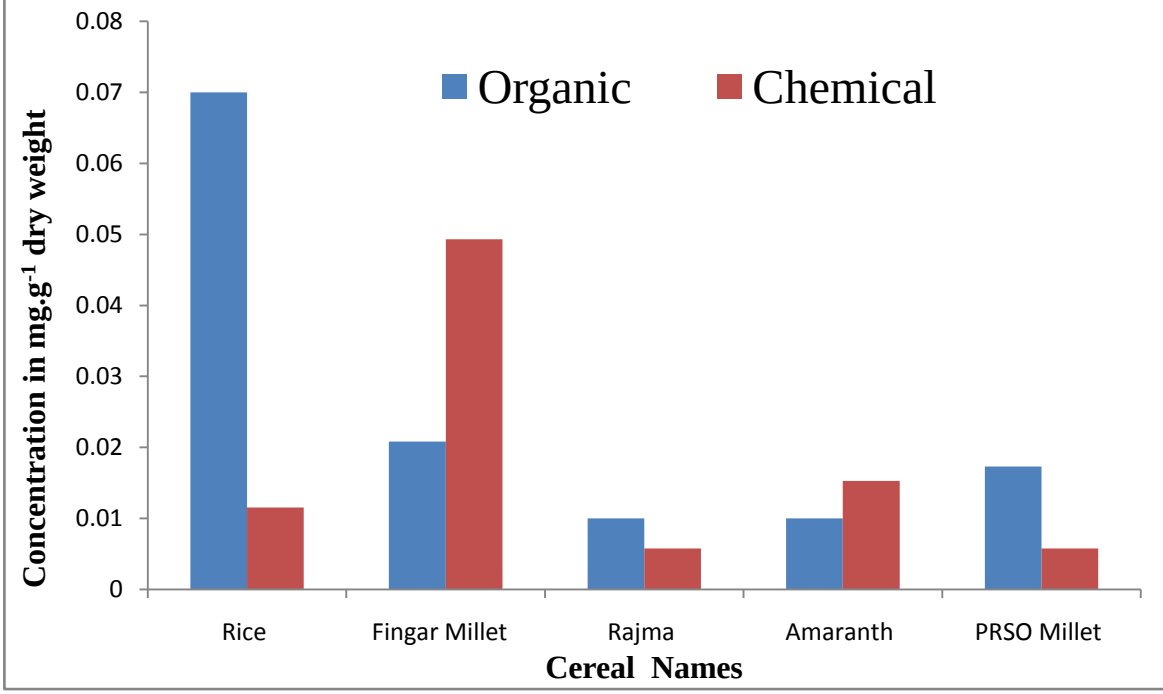


Figure 8: Flavanoid content in conventional as well as organically grown crops.



Discussion

The perception that organic food is better for human health than conventionally grown foods are related to the following broad classes of chemical compounds in plants like nitrogen , metabolites, minerals, heavy metals, vitamins and wide array of phytochemicals. It was therefore thought worthwhile to explore the determination of antioxidant as a likely driver exerting protection when grown in the defense of pesticides.

Attempts were made to explore the possibilities of evaluating phytochemical profiles and total antioxidants along with the data base of primary and secondary metabolites for coherent appraisal of antioxidants as a promising initiative to provide empirical evidence to explore whether organic food is really with the cost and effort and more than a lifestyle choice. Samples of conventional as well as organically grown seeds of Rajma Beans (*Phaseolus vulgaris* L.), *Amranth* species, Fingar Millet (*Eleusine coracana* L.), Prso Mille (*Panicum miliaceum* L.) and Rice (*Oryza sativa* L.) were used in the study.

Beside the above data, the informations collected on other facets of organic agriculture are listed as under:

Spread of monocultures

The spread of monocultures of crops, which are traded in the markets, highly nutritious crops adapted to local ecosystems and local cultural systems have disappeared although local communities still know their value and characteristics of these crops, and local communities utilize them fully for meeting their nutritional and cultural needs.

1. Finger millet (ragi or madua) Botanical Name: *Elusine corcana*
2. Foxtail millet (kauni) Botanical name: *Setaria italica*
3. Banyard millet (Jhangora) Botanical Name: *Echinochloa frumentaceum*
4. Amaranth (marsha, Ramdana) Botanical Name: *Amaranth frumentaceous*

Besides some other minor millets which grow abundantly in any climatic condition but does not have any market area: Nagli, bhagar, bhadi, rada, kodra, barti, mor

Economic non viability of chemical farming

The current investigation based on field studies in Nandurbar area revealed the testimony to the fact that the two most significant ways which are instrumental in pushing the farmer into a debt trap are:

- Introduction of ecologically vulnerable hybrid seeds
- Increased dependence on agrichemical inputs which are necessary to be used with pest prone hybrids. The cost of chemical farming are high, most of the pesticides available in the market are very expensive and out of reach of poor farmer.

Moreover pesticide companies spread false information about efficacy of their pesticides, forcing the farmers to buy their product. The farmer is forced to take loan from rich money lenders to buy pesticides. Pesticides manufacturers and dealers are concerned about selling their products and not much information is available with the farmers on how much of pesticides should be applied and how frequently it should be applied. Application of less than the prescribed dose does not kill the pests while application of too much destroys the plants as well. In either case the farmer is the loser

Production for the export market

Production for the export market leads to the uprooting and destruction of small farmers, while benefiting the large farms. Trade liberalization has led to a shift in cropping patterns from polyculture to monoculture and the shift from mixed cropping to monocropping is stark. Particularly now with globalization and corporate control of agriculture a single multinational company owns the entire supply chain right from the seeds the farmer procures, to the pesticides he needs to save his crop, to the money he loans for carrying the costly operation of chemical farming and then to find depots to store, and the companies to transport his produce, he eventually becomes a puppet in the hands of multinationals.

With all farmers, growing the same commodity over large areas, the prices farmers receive from their crops come down, while the costs of inputs are always rocketing high. As a result the farmer's profit margins get drastically narrowed. As cost of production increase farmers experience a cost prize squeeze. In this entire process only the multinationals are benefited.

Communication with the tribes Bhil, Tadavi, Kokani, Powra, and Mauch of Nandurbar district in particular Nawapur taluka revealed the sustenance of activity as a community group providing livelihood security model for tribal village. The expe-

rience in the context of traditional and indigenous knowledge and constraints is listed as under:

Leptocorsia acuta of rice is one of the major insect pests of rice. Local people mostly the tribe traditionally use some cultural practices to reduce the damage caused by Gandhi bug. This destructive pest usually appears in the rice field at the time of panicle emergence. As soon as the pest appears in the field during flowering, local farmers fix several short wooden bamboo sticks randomly at certain interval in the rice field. Then dead frogs/crabs are placed on top of each stick. Sometime, tribal people also purchase dry salted fish (which emit some fleshy odor) make them into small pieces and tie them with each stick. As the dead frog/crab/fish rot and start to emit foul smell and adult Gandhi bugs are attracted by this foul smell and gather in mass on the rotten frogs/crabs/fishes.

Although this ethnic practice is not successful in combating the pest completely when it appears in a large area with high frequency of pest population it certainly reduces the crop damage in that small holding of the farmer.

The tribal farmers sow ginger (Zingiber offiicinale) after treating with a solution of cow dung. About 10-15 kg cow dung and asafetida species (40-80 g/h) is mixed in 8-10 litres of water. This is enough to treat ginger rhizomes required for one hectare .This practice is helpful for protecting ginger plants from rotting during vegetative growth.

Grain storage containers known by the name of kangi is an indoor container made out of shindola plant (Phragmitis) that is soaked in water for a period of 15 days to one month. The reeds are then woven into a basket and plastered with mud and cow dung. Soaking helps to kill the insects.

Earthen pots are indoor storage containers for storing small quantity of grain. These are made up of burnt clay by the village potter and are of different sizes and shapes they are known by the name of Utrand, and are used for storing pulses or legumes and also seeds. Utrand are either placed on the floor or at any convenient place, and are sealed with lid and then plastered with mud to make the container moisture proof. The grains stored in pots are prevented from infestation.

Although construction of this requires place inside the room for its placement but they are long lasting and also the rats cannot enter the structure. The perusal of information observed during the field visit at Nandurbar district depicted that rural communities use indigenous knowledge for constructing ecofriendly grain storage structures /containers. The rationality behind this is the easy availability of user friendly and cost effective materials.

If steps are taken to integrate scientific rationality with local knowledge then the existing structures/containers could be modified to optimum level for safe storage of grain leading to development of better organic agriculture practice.

The filed investigations, farmer's interviews and general observation during the current investigation revealed that certification of organic farming is a bureaucratic system. Guidelines and restriction imposed by the certification agency are just not easy to be understood by the indigent farmers. Many farmers who are not aware of the organic certification and its restrictions do not fall into the category of certified organic farming viz: 'certified and uncertified 'The products grown from uncertified farmers are treated as conventional produce whereas there from the certified farmers are treated as certified produce As there is a premium price available to the certified organic produce the farms would like to get a certificate from the certifying agency.

It was also observed that the certifying agency should have the ability to assess the organic farmer and then come to a conclusion but they act like some strict government officers without going into the details of the organic farming methods and surprisingly most of the officials do not know farming, their knowledge is theoretical and not practical. Farmers are instructed to follow the set standards that too which are laid down mostly by some foreign countries. In fact a person having knowledge of organic agriculture should be able to identify the methods of organic farming upon a feeling of the soil by walking barefoot and by observing the crop of the area. The weeds and the health of the plant also exhibit the method of farming of that place. One need not look into the records of the farmers at all, those will only be the formalities. In fact a visual inspection of the soil itself is sufficient to find out the truth of the soil and the organic farming methods adopted certifying agencies in fact is deterrent to research in agriculture by the common man and an farmer with small holding who have no qualifications, reputation, position and due apathy of the experts towards the farmers and their methods.

The observation ,which was very evident that every farmer is an innovator as he has to work under variable conditions everyday and he cannot seek the advice of an expert for each and everything and surprisingly most of the officials do not even know farming so they never try to understand the farmers. It is this gap which needs to be bridged by providing practical adaptabilities of the farmers at the field level, because practice of theory in the field is a different aspect altogether .The ignorance

of the so called experts on the practical problems and varied aspects of agriculture is a hindrance in the innovations of the farmer.

Consumers' willingness to pay high prices for food produced out of season has also contributed to the increased use of artificial growing methods and chemicals. The consumers' demands large fshiny, unblemished produce of regular shape. This little edge of preference has put the farmer in a real predicament.

Until there is a reversal of the sense of values which cares more for size and appearance than quality there will be no corrective measure. It is upto each person to ponder seriously how much hardship he is causing by indulging in food so expensively produced.

Far reaching action could be decided upon and put into effect through capacity building which will contribute significantly the farmers of small land holding capacity and seed sovereignty along with natural nutrient mobilization and sustainable use of local resources contributing the society significantly.

Relatively few well-designed studies have compared the antioxidant levels in a given crop grown under conventional and organic systems, where confounding variables are largely eliminated or controlled. The characterization of conventional and organic farming systems in published studies is too sparse to reach more than tentative conclusions. Still, the available evidence is encouraging. Present study focused on the same direction giving evidences about 5 widely consumed seed crops from India. Organically grown produce had higher levels in 3 out of 5cases. On average, the organic crops contained about one-third higher antioxidant and/or phenolic content than comparable conventional produce. Several studies have found levels of specific vitamins, flavonoids or antioxidants in organic food to be two or three times the level found in matched samples. More studies should be focused for concluding remarks in this field.

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None.

Competing Interests

None declared.

References

1. Benrook CM. Elevating Antioxidant Levels in Food through Organic Farming and Food Processing, An Organic Center State of Science Review, 2005; pp.43-44.
2. Alam A, Wani SA. Status of Organic Agriculture Worldwide-An Overview, in Proceedings of National Seminar on Organic Products and Their Future Prospects, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar; , 2003; pp 3-12.
3. Alvares, Claudex. Genes and the Environment, in Anon, The Organic Source Book, The Other India Press, Mapusa, Goa; 2003.
4. Anon. Green Revolution to Organic Revolution, Comprehensive Agric-Commodity Intelligence, April;2003; pp. 21-35.
5. Bisoyi, BN, Majumdar, P, Srivasta, RSM, Creep S. Prospects of Organic Input Production in India, Presented at National Seminar on Organic Farming with Special Reference to Organic Inputs, 21 & 22, August, Bangalore; 2003; pp.23-25.
6. Geier, Bemwad. International Federation of Organic Agriculture Movements, in Sustainable Agriculture Solutions: The Action report of the Sustainable Agriculture Initiative, Novello Press, London; 1999; pp.56-57.
7. Prakash TN. A Theoretical Framework To Promote Organic Produce Marketing in India, Indian Journal of Agriculture Marketing, Conference Number Special. 2003; pp. 1-16.
8. Santucci, Fabio Maria and Pignataro, Filippo. Organic Farming In Italy, Paper for the OECD Workshop on Organic Agriculture, Washington DC, September;2002;pp. 134-135.
9. Sankaram, Ayala. Organic Farming: Eco- Technological Focus for Stability and Sustainability, Indian Farming, June;2001; pp. 7-11.
10. Vasisht AK, Singh C. Growth in Agriculture Technology and Development, in Ecological Agriculture and Sustainable Development, Indian Ecological Society and Centre for Research In Rural Development, Chandigarh; 1997; pp. 512-520.
11. Manach, Mazur. Bioavailability and bioefficacy of polyphenols in humans. I. Rev. 97 bioavailability studies, Am. J. Clin. Nutr. 2005;81:230S-242S.
12. Guri A. Variation in glutathione and ascorbic acid content among selected cultivars of Phaseolus vulgaris prior to and after exposure to ozone. Can. J. Plant Sci. 1983;63:733–7.
13. Shahidi, Naczk. Food phenolics: Sources, Chemistry, Effects, Applications, Technomic Publishing Company Inc., Lancaster PA.; 1995.pp: 231-245.
14. Zhishen J, Mengcheng T, Jianming W. The determination of flavonoid contents in mulberry and their

scavenging effects on superoxide radicals. Food Chemistry. 1999; 64:555−9.

15. Braca A, Tommasi ND, Bari LD, Pizza C, Politi M, Morelli I. Antioxidant principles from Bauhinia terapotensis. Journal of Natural Products. 2001; 64: 892–5.
16. Prieto M, Pineda, Aguilar M. Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: specific application to the determination of vitamin E. Analytical Biochemistry. 1999; 269: 337–41.