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Comparison of nutritional quality of organically versus conventionally grown tomato

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ABSRACT

Tomato crop was grown using organic manures and chemical fertilizers and the effect of organic farming on nutritional profile, quality characteristics, toxic parameters were studied. The experiment was laid out in a randomized block design with fifteen treatments consisting of four organic manure treatments of vermicompost (VC), poultry manure (PM), farm yard manure (FYM), cow dung (CD) and recommended dose of chemical fertilizers, i.e., conventional farming as control. Organically and conventionally grown tomato were analysed for their nutrient composition. Application of organic manures was found to be significantly influence the nutrient content (micro-nutrients, TSS, lycopene etc.) compared to conventional fertilizers application.

Key words: Organic farming, fertilizers, tomato, nutritional quality.

INTRODUCTION

Tomato is the world's largest vegetable crop after potato and sweet potato. It is one of the most protective food. In terms of human diet, the tomato is a potent major component of daily meals in many countries and constitutes an excellent source of health-promoting compounds due to the balanced mixture of minerals and antioxidants including vitamin C, total carotenoids. The purpose of this paper is to show how the health-promoting compounds of tomato fruit may be improved through controlling conditions of production through organic farming. In the face of a global market economy and public awareness of health attributes of food, obtaining tomato fruit of very high health quality is essential for insuring health benefit and consequently consumer satisfaction. This study will then conclude on the better strategy to adopt for improvement of the health-promoting phyto-chemicals of tomato. Organically and conventionally grown tomato were analysed for their nutrient composition. Application of organic manures was found to significantly influence the nutrient content of these crops compared to conventional fertilizers.

MATERIALS AND METHODS

Tomato crop was grown using organic manures and chemical fertilizers and the effect of organic farming on nutritional profile, quality characteristics and toxic parameters was studied. The experiment was laid in an unused land. The experimental design used was Randomized Block Design (RBD) with 5 treatments, and 4 replications each of organic manures i.e vermicompost (VC), farmyard manure (FYM), poultry manure (PM), cow dung (CD) and conventional farming as control. Tomato plots (Gross plot 240 m^2 and net plot 210 m^2 (2 × 1.5 m^2) were laid in four replications with the following treatments for each crop. Nursery beds were raised for tomato as per recommendations (Chadha, 3). Organic manure was used to raise nursery beds to avoid contamination with chemical fertilizers. The nursery beds were treated with *Trichoderma viride* and *Pseudomonas fluorescence* to protect seeds and seedlings from pests. Soon after sowing, the beds were irrigated everyday morning. Seedlings were ready for transplantation in one month after sowing. Before transplanting, the seedlings were treated with 0.1% *Trichoderma viride*. Fresh crop samples and dry powders of tomato were analysed for nutrient profile (ash, mineral content, *In vitro* iron availablity, crude fibre, vitamin C and total carotenoides (AOAC, 1)). Analysis was carried out in duplicates. Nutrient analysis carried out on fresh weight basis.

RESULTS AND DISCUSSION

Ash content of organically grown tomato was found to be significantly higher compared to conventionally grown crops. Vermicompost, farmyard manure, poultry manure application to tomato crop registered significantly higher ash content compared to conventionally grown crop. Among the organic manures tested vermicompost application to tomato crops resulted in significant increase in iron content. Similar results were reported by Uma Reddy. (13)

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in tomato and onion crops with vermicompost application. Worthington (18) reported higher iron content in spinach, tomato, turnip, apple, cabbage, carrots, celery, leek, lentil, lettuce, pepper, potato, apple, pears in organically grown crops, compared to conventionally grown ones. The zinc content of all organically grown vegetables was found to be significantly higher compared to conventionally grown vegetables of both the seasons. Among the various organic manures tested in both the seasons vermicompost application resulted in significantly higher zinc content in tomato crops. Uma reddy (13) reported similar increase in zinc content of organically grown vegetables. Among the organic manures tested, application of poultry manure to tomato crops registered significantly higher calcium content in both the seasons. Similar increase in calcium content in organically cultivated vegetables was reported in spinach, cabbage, carrots, beans, tomato, turnip, apple, celery, leek, lentil, lettuce, pepper, potato, apple and pears by Worthington, (18). Magnesium content followed different trend in tomato, where poultry manure application registered in significantly higher magnesium content in *kharif* crop. However, a non significant trend was observed with *rabi* grown tomato among all the treatments applied (Table 1). Increase in magnesium content of organically grown beetroot, spinach, tomato, turnip, cabbage, lettuce, spinach, carrots, apples, pears was reported by Worthington (18). The absorption of micronutrients such as iron and zinc from the soil was significantly influenced by the application of organic manures, *i.e.*, vermicompost, poultry manure, farm yard manure and cow dung. Soil that has been managed organically has more microorganisms, which produce many compounds that influence the plant to absorb more micronutrients from soil. It is also reported that substances such as citrate and lactate combine with the soil minerals and make them more available to plant roots. For iron, in particular, this is especially important because many soils contain adequate iron but in an unavailable form. The presence of these microorganisms explains the trend showing a higher mineral content of organic food crops (McClintock, 9).

Crude fibre content of organically grown tomato crop was found to be significantly higher compared to conventionally cultivated vegetables of both seasons. Vermicompost, poultry manure and cow dung application to tomato registered significantly higher crude fibre content in *kharif* crop, whereas in *rabi*, vermicompost application registered significantly higher crude fibre content compared to conventionally grown tomato crop. Similar increase in fibre content was reported in organically grown apples compared to conventional ones (Weibel, 16). Vitamin C content of tomatoes was found to be significantly higher compared to conventionally grown vegetables in both the seasons (Table 2). Similar increase in vitamin C was reported in organically grown vegetables (beetroot spinach, tomato, turnip, cabbage, lettuce, spinach, carrots, apples, pears) compared to conventionally cultivated crops by Heaton (6); Worthington (18); Asami *et al.* (2); Venkat Rao (15); Lumpkin (8), and Uma Reddy *et al.* (14). Among all the organic manures tested, vermicompost application to amaranthus, spinach and tomato crops in both the seasons registered significantly higher vitamin C content. Non-significant trend was observed with *rabi* spinach among all the treatments applied. Vermicompost application to tomato crops resulted in significantly higher total carotenoids in *rabi* season compared to other organically cultivated crops. Cowdung application to *kharif* tomato crop and vermicompost application to *rabi* tomato registered significantly higher total carotenoides. Significantly, lower total carotenoides were found in all crops cultivated with chemical

Table 1. Mineral contents of organically and conventionally grown tomato crop.

Treatment	Ash		Iron		Zinc		Calcium		Magnesium	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
VC	0.2	0.22	0.6	0.67	34.4	35.95	53.82	55.5	0.51	0.55
FYM	0.2	0.22	0.54	0.64	34.4	35.95	50.21	51.75	0.35	0.39
PM	0.2	0.22	0.57	0.67	35.01	28.24	58.8	60.33	0.43	0.47
CD	0.2	0.21	0.35	0.45	23.99	25.54	35.84	37.39	0.34	0.38
Control	0.16	0.16	0.3	0.38	23.03	24.58	31.83	33.39	0.27	0.31
F value			*	*	*	NS	*	*	*	*
$CD_{0.01}$	0.01	0.01	0.02	0.05	0.15		0.43	0.31	0.17	0.02
CV%	1.7	2	2	5.7	0.9		0.6	0.4	3	2.9

*Significant at P = 0.01 level

NS = Not significant

Table 2. Nutrient content (g/100 g) of organically and conventionally grown tomatoes.

Treatment	Crude fibre		Vitamin C		Total carotenoides	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Vermicompost	6.10[b]	7.35	23.83[b]	25.90	0.28	0.30
Farm yard manure	5.00[a]	7.15	22.15	23.53	0.21	0.21
Poultry manure	6.00[b]	7.25	20.66[a]	24.14[a]	0.25	0.25
Cowdung	6.00[b]	5.95	24.73[b]	20.89[a]	0.23	0.22
Control	5.00[a]	5.75	20.32[a]	18.83	0.20	0.19
$CD_{0.01}$	0.18*	0.01	1.69*	1.54*	0.02*	0.03*
CV%	1.10	0.10	2.70	2.40	2.90	4.30

*Significant at P = 0.01 level
Values with similar superscripts are not significant in column
NS = Not significant

Table 3: Quality parameters (g/100g) of organically and conventionally grown tomato.

Treatment	TSS		Acidity		TBARS(%)	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Vermicompost	11.50	11.75	565.63	571.43	1.02	1.02
Farm yard manure	11.25	11.25	433.25	516.66	0.89[a]	0.89[a]
Poultry manure	11.25	11.75	531.25	528.57	1.26	1.26
Cowdung	10.75	10.50	522.25	502.38	0.64[a]	0.64[a]
Control	10.25	10.50	387.50	469.04	0.64[a]	0.64[a]
CD(0.01)	NS	NS	83.32*	14.19*	0.33*	0.33*
CV%	6.20	4.80	6.20	1.00	13.50	13.50

*Significant at P<0.01 level
Values with similar superscripts are not significant in column
NS = Not significant

Table 4: Lycopene content (mg/g) of organically and conventionally grown tomato.

Treatment	Tomato			
	Kharif	*Kharif*	*Rabi*	*Rabi*
Vermicompost	6.41[a]	2184.33	7.43	2359.44
Farm yard manure	6.20	2302.07	6.54	2426.95
Poultry manure	6.34[a]	2420.28	7.77	2483.30
Cowdung	6.11	2277.38	5.20[a]	2209.91
Control	5.88	2649.48	5.58[a]	3108.93
$CD_{0.01}$	0.14*	177.43*	0.97*	107.76*
CV%	0.80	2.70	5.40	105.00

*Significant at P<0.01 level
Values with similar superscript are not significant in column

fertilizers compared to organically grown vegetables (Table 2).

A non significant trend was observed with total soluble solids (%) (TSS) in tomato crop grown in both *kharif* and *rabi* crops. Increase in total soluble solids (%) in onion was reported with vermicompost application compared to chemically fertilized crop reported by Uma Reddy *et al.* (14); Prabakharan and Pitchai (11); and Lumpkin (8) also reported increase in total soluble solids in organically grown crops. Poultry manure application registered significantly higher acidity in tomato crops of both the seasons compared to chemical fertilized and other organically cultivated tomato. Vermicompost application to tomato crops registered significantly higher total antioxidant activity in both the seasons. Conventionally grown crops contained significantly lower total antioxidant activity in both seasons (Table 3). Similar increase in antioxidant activity in organically cultivated crops was reported by Asami *et al*. (2). Organic production methods which are limited in the use of insecticides, herbicides and fungicides compared to conventionally cultivated plants may need to synthesize their own chemical defense mechanisms, and the increase in antioxidant activity has been attributed to this need. Vermicompost application to tomato crop cultivated in kharif and poultry manure application in rabi registered significantly higher lycopene content compared to other organically grown tomato. Lycopene content of conventionally cultivated tomato was found to be significantly lower compared to all other treatments in both the seasons (Table 4). Similar increase in lycopene in organically grown tomato was reported by Lumpkin (8).

Conventionally grown tomatoes were found to contain significantly higher nitrates compared to organically grown crops. Among the organic manures, poultry manure application to tomato of both the seasons resulted in significantly higher nitrates (Table 5). Increase in nitrate levels were reported in conventionally grown crops potatoes, lettuce, leeks, and spinach by Finesilver *et al*. (4). The nitrates are commonly developed by the application of nitrogen through chemical fertilizers and as well as by organic manures. Nitrate level in plants is determined by a number of factors, such as variety, light intensity, climate and soil and specifically nitrogen supply. Nitrogen application depends on the amount of the fertilizer applied, availability of nitrogen during the period of growth and time of application to the plant, has been considered as the source of nitrate variability in many studies compared to organically versus conventionally grown produce. In many organic fertilizers, the organically bound nitrogen is relatively insoluble and easily not available to the plant. In contrast, the nitrogen in mineral fertilizers is soluble and is readily available to the plant (Finesilver *et al*., 4). In general, extensive use of chemical fertilizers and organic manures with high nitrogen increase nitrate content in vegetables regardless of the kind of fertilizers or organic manures. There is also a higher risk of contamination of ground water with nitrates when over fertilization takes place (Sohn and Yoneyama, 12).

Endosulfan residues were not detected in organically cultivated crops, as no endosulfan was sprayed to control pests in organically grown crops and pest mangement was done by spraying neem oil. In conventionally grown crops, the residues of endosulfan were 0.214 and 0.585 mg/kg in tomato, in kharif and rabi seasons respectively. The concentration of endosulfan residues in all conventional crops was with in maximum residue limit (MRL), *i.e.* 2 mg/kg (Narasimha Rao, 10). Higher levels of pesticide residues were reported in conventional foods, *viz.*, fruits, vegetables, meats, dairy and processed foods especially in conventionally produced foods (Gour and Sreenivasa Rao 5; Winter and Davis, 17). All pesticides after their use in agro-ecosystem invariably leave their residues in various quantities and the hazards depend on chemical nature of the compound. Since most pesticides are toxic in nature, their continuous ingestion even in minute quantities can result in accumulation in body tissues, which may lead to adverse effects on health. Undoubtedly, many of these pesticides used today may cause cancer, mutations and other problems (Gour and Sreenivasa Rao, 5). The indiscriminate application of chemical fertilizers and pesticides not only pose health risk but also leads to the degradation of soil and water and therefore cause damage to the ecological foundation essential for sustainable advances in productivity which have led to the on set of a fatique in the green revolution (Kesavan and Swaminathan, 7).

Organic farming is a reliable way to increase nutrients, *i.e.* micronutrients, decrease nitrate levels and also reduce exposure to pesticides through foods. Although many people in the third world do not have enough food even once a day, those in the developed countries are concerned about the quality of food. Increasing attention has been focused on chemical residues of food because of their long-term effects on human as well as environmental health. Alert notices issued by developed nations importing Indian foods with respect to the presence of pesticide residues beyond prescribed levels have already led to serious discussions on the subject of contamination of foods with pesticide residues. Reducing dietary exposure to pesticide residues is an important goal of public and environmental health. Organic farming, seems to offer a low-residue alternative to conventionally grown produce, where exposure to pesticides is minimized and one major reason why consumers now prefer to buy organic foods.

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