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Effect of organic nutrition on quality and shelf life of baby corn (*Zea mays* L.)

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Abstract
An investigation was conducted at College of Agriculture, Vellayani to during kharif season of 2019 to study the effect of organic nutrition practices on growth, yield, quality and shelf life of baby corn. The experiment was laid out in randomized block design with 10 treatments replicated thrice during kharif (May to September) in 2019. Organic manure *viz*., vermicompost, coirpith compost and poultry manure along with insitu green manuring and biofertilizer (PGPR mix I) were applied to the field. In the control treatment inorganic fertilizers were applied @135:65:45 kg NPK ha^{-1}. Poultry manure application along with in situ green manuring or biofertilizer application improved the quality and shelf life of baby corn. Poultry manure application along with PGPR mix I or *in situ* green manuring was effective for producing higher nutrient content in baby corn. Application of poultry manure or vermicompost with PGPR was found to improve the sensory parameters, consumer preference and shelf life of baby corn.

Keywords: Baby corn, PGPR mix I, poultry manure

Introduction
Organic farming is a holistic way of farming and is one of the several approaches suggested to meet the objective of sustainable agriculture. Organic farming improves the soil quality by making sufficiently higher amount of nutrients available to the crops by enhanced microbial activity in the soil. Organically produced crops have more demand compared to conventional crops. Organic farming provides higher net profit to farmers compared to conventional farming mainly due to the premium price of the certified organic produce.

Baby corn is crop recently gained consumer preference especially in urban and sub- urban areas. The young finger like unfertilized cob with 1-3cm emerged silk in baby corn is preferably harvested within 1-3 days of silk emergence. Since baby corn is preferred as a raw vegetable or in partially cooked form in soups, salads and Chinese food preparations, nutrient management with organic resources assumes more importance with respect to nutritive value, taste and overall consumer preference.

Good health is considered as an asset in any society and staying healthy through consumption of healthy and quality food without contamination is highly relevant in current times. Prospects are higher in organic cultivation of baby corn which is preferred as a raw vegetable in urban areas. However, the influence of organic nutrition in baby corn has not been studied so far in Kerala to make an organic recommendation to the farmers. With this background the present study was conducted to study the influence of organic nutrition on quality and shelf life of baby corn.

Materials and Methods
The study consisted of a field experiment which was conducted in the instructional farm at College of Agriculture, Vellayani. The experiment was laid out in randomized block design, with ten treatments replicated thrice. The treatments were T_1- vermicompost, T_2- coir pith compost, T_3- poultry manure, T_4- *In situ* green manuring with cowpea + vermicompost application, T_5- *In situ* green manuring with cowpea+ coir pith compost application, T_6- *In situ* green manuring with cowpea + poultry manure application, T_7- PGPR mix I + vermicompost, T_8- PGPR mix I + coir pith compost, T_9- PGPR mix I + poultry manure and T_{10}- 135:65:45 kg NPK ha^{-1} as inorganic fertilizers (control). Organic sources were applied as basal on nitrogen equivalent basis as per the treatments.

In the case of control, the N and K were given in two split doses, ½ as basal+ ½ at 25 DAS and full quantity of P was given as basal. For *in situ* green manuring, cowpea was raised and incorporated at 50 per cent flowering stage and sowing of baby corn was done two weeks after incorporation. The PGPR mix I was applied as seed treatment @ 30 g kg^{-1} followed by soil application @ 110g m^{-2} area.

Observations on quality parameters like crude protein content of cob and stover, starch content, ascorbic acid content and total soluble sugar content of cob were made. Organoleptic study was conducted to evaluate the sensory attributes of fresh baby corn as well as during storage. Sensory evaluation was done by using a nine point hedonic scale. The cob was salted and kept for 3 minutes and then steam boiled for 5 minutes. The hedonic scale rating was applied for the parameters such as appearance, colour, taste, flavor, texture and overall acceptability. The scoring was done at the laboratory of Department of Community Sciences, College of Agriculture, Vellayani by a panel of judges. The judges were requested to taste the samples and mark their scores based on their likeness in the score card.

To assess the shelf life of cobs, the overall visual quality, moisture loss and sensory parameters were analyzed on 3rd day and 6th day of storage. The visual quality of the cob with husk on 3rd and 6th day of storage was evaluated using a nine point hedonic scale.

Results and Discussion

The organic nutrition treatments could significantly influence the quality parameters and shelf life of baby corn. Quality attributes like ascorbic acid content and total soluble sugar content were significantly influenced by the organic nutrition treatments. The treatment T_6 in which poultry manure application and *in situ* green manuring were done recorded the highest ascorbic acid content (14.83 mg g^{-1}), which was significantly superior to all other treatments (Table 1). The treatment T_9 (application of poultry manure and PGPR mix I) recorded highest total soluble sugar content (6.75° Brix) which did not vary statistically from T_{10} (6.64 ° Brix), T_7 (6.63° Brix), T_8 (6.59° Brix) and T_6 (6.54° Brix) (Table 1). The crude protein content and starch content were not significantly influenced by the treatments.

Table 1: Effect of organic nutrition on starch, ascorbic acid and total soluble sugar content of baby corn cob

Treatments	Starch content (per cent)	Ascorbic acid (mg g^{-1})	TSS(°Brix)
T_1- Vermicompost	7.86	7.54	6.24
T_2- Coir pith compost	7.09	7.03	6.21
T_3- Poultry manure	6.96	12.03	6.30
T_4- *In situ* green manuring with cowpea + vermicompost	7.93	6.86	6.35
T_5- *In situ* green manuring with cowpea + coir pith compost	7.34	9.18	6.32
T_6- *In situ* green manuring with cowpea + poultry manure	6.30	14.83	6.54
T_7- Vermicompost + PGPR mix I	6.91	7.88	6.63
T_8- Coir pith compost + PGPR mix I	7.06	7.65	6.59
T_9- Poultry manure + PGPR mix I	6.32	8.22	6.75
T_{10} (control) -135:65:45 kg NPK ha^{-1} as inorganic fertilizers	7.08	9.29	6.64
S.Em (±)	0.09	0.41	0.02
CD (0.05)	NS	1.240	0.256

Application of poultry manure application along with *in situ* green manuring produced the highest ascorbic acid content in baby corn cob. According to Bybordi and Malkouti (2007) [5], the content of ascorbic acid in plant is a function of the content of ascorbic acid oxidase enzyme and zinc and manganese concentrations have key roles in enabling the ascorbic acid oxidase enzyme pathways. The concentration of ascorbic acid is therefore a function of the content of ascorbic acid oxidase enzyme and zinc and manganese concentrations within the plant. Amanullah *et al*. (2007) [2] reported that the Zn content ranged from 90-460 ppm in various types of poultry manure while the Mn content ranged from 190-590 ppm. The higher content of Zn and Mn in poultry manure would have resulted in improvement in the uptake and utilization of zinc and manganese, increasing the activity of the ascorbic acid oxidase enzyme resulting in more concentration of ascorbic acid. Similar results were reported by Srinivasan *et al*. (2014) [11] in baby corn. The legume cowpea used for *in situ* green manuring has a C:N ratio of 13.9:1 (Kirchmann, 1988) [8] and is quickly decomposed converting the nitrogenous compounds like protein to nitrate and the mineral constituents into more soluble form (Palaniappan and Annadurai, 1999) [9]. The improved availability of trace elements consequent to the green manuring coupled with the beneficial influence of poultry manure application would have reflected in accumulation of ascorbic acid in the cob.

The higher potassium content in poultry manure than other organic sources and the potassium nutrition favour the sugar accumulation as reported by Xing *et al*. (2020) [14]. The PGPR application is also reported to have a favourable effect on sugar content of the plant. As pointed out by EL-Hamid *et al*. (2006) [6], the improved sugar content in the cob would have been due to the synergistic effect of *Azotobacter* and *Azospirillum* present in the PGPR consortium.

Analysis of sensory parameters of fresh baby corn was done using organoleptic study and the organic nutrition treatments were found to be superior to the chemical fertilizer treatments (Table 2). The use of organic sources (poultry manure and vermicompost) and biofertilizer (PGPR mix I) resulted in superior sensory attributes like appearance, colour, taste, flavour and texture and increased the likeness by the consumers. The preference by the consumers was based on the taste, flavor, sweetness and juiciness of the fresh steamed baby corn. Higher content of total soluble sugar in cob produced with these treatments might have contributed to its sweetness and taste. As reported by Worthington (2001) [13], crops raised by organic practices contain more vitamin C, iron, magnesium, phosphorus and less nitrates than conventional crops and the reduced nitrate level leads to higher quality and better consumer acceptance. Kavya (2017) [7] reported higher sensory values of baby corn grown with manurial combinations involving biofertilizer. In control treatment a higher quantity of nitrogen (135 kg) was applied through inorganic source which might have negatively

influenced the sensory quality of the fresh produce and resulted in lower values for sensory attributes. The negative influence of nitrogen nutrition on appearance and sweetness was previously pointed out by Raese *et al*. (2007) [10] in apple.

Table 2: Effect of organic nutrition on sensory parameters of fresh baby corn cob

Treatment	Appearance		Colour		Taste		Flavour		Texture		Overall acceptability	
	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV
T_1	7.9	82.90	8.1	89.85	8.1	92.80	8.2	89.30	8.5	105.00	8.3	89.40
T_2	8.2	91.70	7.6	69.05	7.8	76.90	8.1	80.60	8.4	91.40	8.3	89.48
T_3	8.4	102.70	8.3	107.50	8.0	86.10	8.1	88.80	8.6	109.20	8.4	93.70
T_4	8.3	93.90	8.2	101.70	8.2	103.10	8.3	95.20	8.3	88.76	8.5	98.00
T_5	8.3	97.20	7.7	64.80	8.0	86.10	8.2	89.50	8.4	102.19	8.4	98.50
T_6	8.7	102.10	8.4	115.30	8.2	101.30	8.4	104.10	8.7	110.10	8.6	107.10
T_7	8.8	137.90	8.8	142.40	8.7	142.00	8.8	139.70	8.9	130.60	8.7	116.20
T_8	8.2	88.40	8.6	130.70	7.4	108.00	8.7	134.00	8.7	107.52	8.5	102.80
T_9	8.8	136.89	8.7	134.60	9.0	150.50	8.9	148.60	8.8	121.70	8.8	125.30
T_{10}	7.5	61.90	7.6	61.10	7.7	64.20	7.7	63.20	8.0	66.40	8.3	84.60
K value	53.95*		60.2*		50.62*		67.51*		25.79*		11.69	
CD (0.05)	9.46											

(MS- Mean score, MRV- Mean rank value) * Significant @ 5%

Organic nutrition practices excelled the chemical fertilizer application in the overall visual quality and sensory parameters of baby corn in storage also. The overall visual quality at 6th day of storage was significantly influenced by the treatments and T_9 recorded the highest mean rank value (122.15) for overall visual quality (Table 3). The coir pith compost application was found to have least consumer acceptance with respect to overall visual quality on 6th day of storage. When coir pith compost is used as an organic manure, there is a possibility that it may contain chloride which can adversely affect the crop growth and quality of produce. Chlorine reducing the firmness of fruits in tomato was reported by Acedo *et al*. (2009) [1].

Organic nutrition practices involving poultry manure or vermicompost with PGPR mix I was observed to have higher organoleptic score with respect to different sensory attributes during 3rd and 6th day of storage (Table 4). Organoleptic scores were low in T_{10} (control) wherein chemical fertilizers were applied as sources of nutrients.

Table 3: Effect of organic nutrition on overall visual quality of cob on 3rd and 6th day of storage

Treatments	Overall visual quality			
	3rd day		6th day	
	MS	MRV	MS	MRV
T_1- Vermicompost	8.40	97.05	6.33	92.62
T_2- Coir pith compost	8.30	90.12	5.66	76.12
T_3- Poultry manure	8.35	94.70	6.66	101.55
T_4- *In situ* green manuring with cowpea + Vermicompost	8.60	115.35	7.33	108.52
T_5- *In situ* green manuring with cowpea + coir pith compost	8.75	90.25	6.66	93.97
T_6- *In situ* green manuring with cowpea + poultry manure	8.50	106.20	7.00	110.57
T_7- Vermicompost + PGPR mix I	8.60	110.90	8.33	110.87
T_8- Coir pith compost + PGPR mix I	8.45	97.17	7.00	107.02
T_9- Poultry manure + PGPR mix I	8.70	120.05	8.66	122.15
T_{10} (control) -135:65:45 kg NPK ha^{-1} as inorganic fertilizers	8.20	83.20	6.66	84.57
K value	12.87		17.44*	
CD (0.05)	9.460			

(MS- Mean score, MRV- Mean rank value)

Table 4: Effect of organic nutrition on sensory parameters of cob on 3rd day of storage

Treatment	Appearance		Colour		Taste		Flavour		Texture		Overall acceptability	
	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV
T_1	7.9	84.45	8.3	96.15	7.6	87.00	7.8	90.65	7.7	94.67	7.7	98.68
T_2	8.0	85.62	7.6	74.87	7.65	90.72	7.8	83.47	7.55	95.20	7.6	97.30
T_3	8.2	107.35	8.2	94.70	7.75	96.37	7.9	82.70	7.6	101.00	7.9	105.67
T_4	8.1	94.87	8.6	117.50	8.0	114.10	8.0	108.90	8.0	107.32	8.0	110.12
T_5	8.3	109.52	8.3	99.55	7.6	86.10	7.7	89.95	7.7	90.72	7.6	95.23
T_6	8.3	116.52	8.5	112.65	7.9	101.61	7.9	106.67	7.95	100.47	7.7	104.13
T_7	8.4	127.35	8.5	116.05	8.05	116.92	8.05	122.70	8.2	110.22	8.3	128.25
T_8	8.5	114.17	8.4	107.80	8.3	113.20	8.0	123.40	8.2	106.80	8.3	125.56
T_9	8.5	126.17	8.6	115.21	8.1	120.65	8.1	136.50	8.4	113.12	8.4	132.40
T_{10}	7.7	76.75	8.0	74.80	7.5	83.27	7.65	80.05	7.3	85.45	7.3	78.40
K value	28.72*		16.49		21.09*		32.30*		4.93		23.95*	
CD (0.05)	9.46											

(MS- Mean score, MRV- Mean rank value) * Significant @ 5%

Table 5: Effect of organic nutrition on sensory parameters of cob on 6th day of storage

Treatment	Appearance		Colour		Taste		Flavour		Texture		Overall acceptability	
	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV	MS	MRV
T_1	7.9	80.30	8.2	96.25	7.6	92.00	7.8	92.62	7.6	99.67	7.8	99.68
T_2	8.0	86.30	7.6	81.26	7.5	95.72	7.7	88.47	7.5	98.20	7.7	98.30
T_3	8.0	88.20	8.1	98.70	7.7	101.37	7.8	85.70	7.7	106.00	8.1	110.67
T_4	8.3	108.10	8.6	120.50	8.1	120.10	8.1	112.90	7.6	110.32	8.2	115.12
T_5	8.2	104.00	8.4	103.55	7.7	91.10	7.7	93.85	8.0	95.72	7.9	106.23
T_6	8.6	117.90	8.5	115.65	7.9	106.61	7.9	113.67	7.8	106.47	8.1	110.13
T_7	8.5	118.04	8.6	119.05	8.0	121.92	8.1	128.70	7.9	116.80	8.4	132.25
T_8	8.4	116.00	8.4	110.80	8.4	120.20	8.2	125.40	8.3	118.22	8.4	130.16
T_9	8.6	129.90	8.5	118.21	8.2	125.65	8.4	136.05	8.4	128.12	8.5	138.40
T_{10}	7.6	60.40	7.9	79.80	7.6	88.27	7.7	81.05	7.4	88.45	7.6	83.40
K value	15.33		11.12		17.00*		25.46*		25.98*		26.29*	
CD (0.05)	9.46											

(MS- Mean score, MRV- Mean rank value) * Significant @ 5%

Application of poultry manure as an organic source favourably improve the soil properties through the supply of micro nutrients and other growth promoting substances. Bitzer and Sims (1988) [4] reported that a long term increase in the level of nutrients such as B, Ca, Mg and Zn can be expected on application of poultry manure. Importance of micro nutrients like B on keeping quality and shelf life of the fruits and tubers have been indicated by Tisdale *et al*. (1995) [12] and this could have been attributed as the reason for enhanced storage quality under poultry manure application. Vermicompost is a high value organic manure that contains all essential nutrients for crop growth. In addition to that, the N released by organic sources such as vermicompost has got a beneficial effect on the shelf life of fruits, due to the delayed activity of organic N compounds in the source as suggested by Asano *et al*. (1981) [3].

Conclusion

The combined application of organic sources and PGPR would have improved the rhizosphere activity of the beneficial microorganisms releasing even the insoluble forms of organic nutrients into plant available form contributing to the quality attributes and shelf life of the crop.

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