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Research Article

Tomato Quality from Organic and Conventional Production in the Selected Area of Dharan, Sunsari, Nepal

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Abstract

From the selected area of Dharan, Sunsari, Nepal, conventional and organic tomatoes were grown and tested with different parameters. Conventional tomatoes contained less value of Mg, Ca, K, Cu and Mn, but more value of Fe than organic tomatoes, where as Pb and Ni were not detected.The Zn was found to be same in both tomatoes sample. The sizes of conventional tomatoes were reportedly bigger than organic tomatoes. The viscosity and surface tension of organic tomatoes juice were reported to be higher than in conventional tomatoes juice. The refractive index value was found to be lower in conventional tomatoes juice than in organic tomatoes juice. The vitamin C value was found to be higher in conventional tomatoes juice than in organic tomatoes juice. The comparative study of color, juice containing capacity, storage capacity and firmness of organic and conventional tomatoes of Dharan,Sunsari,Nepal has also been included.

Keywords: Tomato seeds; Urea; Manures; Vitamin C; Metals; Juice.

Introduction

Nowadays organic farming is very famous than conventional farming in our Country. Atmospheric conditions, soil environment and farming process influences the tomato farming. After potato, the tomato is used widely (Lugasi *et al*., 2003).

From the tomatoes, many foods are possible such as sauces, catsup (ketchup), puree, pastes, soups, juices and juice blends etc (Preedy and Watson, 2008).Tomato is an important source of micronutrients, certain minerals and carboxylic acids (Caputo *et al*., 2004; Hernandez-Suarez *et al*., 2007). Tomatoes and tomato products are antioxidant and carotenoids (George *et al*., 2004; Sahlin *et al*., 2004; Ilahy *et al*., 2011; Pinela *et al*., 2012). The consumption of tomatoes has been shown to reduce the risks of cardiovascular disease and certain types of cancer, such as cancers of prostate, lung and stomach (Canene-Adams *et al*., 2005).

It was reported, lycopene plays a role in the prevention of different health issues, cardiovascular disorders, digestive tract tumors and in inhibiting prostate carcinoma cell proliferation in humans (Levy and Sharoni, 2004).

It was noticed that the higher levels of bioactive compounds in organically produced tomato fruits compared to conventional ones, but not all studies have been consistent in this respect (Rembiałkowska, 2004; Ordonez-Santos *et al*., 2011; Chassy *et al*., 2006). Organic tomatoes give good prices compared to conventional tomatoes (Kapoulas *et al*., 2011).

Tomato farming depends upon region, climate, soils, pests, diseases, and economic factors (Mitchell *et al*., 2007).

The differences between organic and conventional production tomatoes are observed by the use of the fertilizer as: organic-manure; conventional-mineral fertilizer (Kapaulas, 2012).

Some studies report better taste, higher Vitamin C contents and higher levels of other quality related compounds for organically grown products (Mitchell *et al*., 2007, Caris-Veyrat *et al*., 2004), whereas several other studies have found the opposite characteristics between organically and conventionally grown vegetables (Caris-Veyrat *et al*., 2004).

In the United States in 2003 originated from California farms, ninety three percent of the organic tomatoes sold (Economic Research Service, 2005).

It was studied by (Barrett *et al*., 2007) organically grown products experienced a doubling in percent penetration of organic sales into retail markets during the period from 1997 to 2003.

The quality of tomato fruit was studied by Pilipavicius (2014) during 2008-2010 also. The study was located in the Sapes, North eastern Greece, using two different growing systems: organic and conventional and found organic tomatoes contained more carotenoids, more minerals (P, K, Mg, Ca, Zn, Cu, Ni), far less heavy metals (Zn, Cu, Ni, Fe), less nitrates, about 30-40% less and any pesticide residues.

The levels of some phenolic compounds were known to be higher in organic fruit (Petkovsek *et al.*, 2010). Plants create phenolic compounds for many reasons, but a major reason is to make plant tissues less attractive to herbivores, insects and other predators. Accordingly, it is important to sort out if higher levels of phenolic compounds affect the taste of organic fruits and vegetables when compared to conventionally grown (Kapoulas *et al.*, 2011).

Vitamin C of tomato fruits accounts for up to 40% of the recommended dietary allowance for human beings. Farm management skills combined with site-specific effects contribute to high Vitamin C levels, and the choice of variety significantly influences the content of ascorbic acid (Ilahy *et al.*, 2011).

Ascorbic acid content in organically fertilized tomatoes ranges between 29% and 31% (Verma *et al.*, 2015), which is higher than the results obtained from tomatoes that were fertilized with mineral solutions.

The objective of this study is to compare the quality value of processing tomatoes grown on matched commercial grower fields in selected area of Dharan, sunsari. Several tomato quality components, including color, size, viscosity, surface tension, refractive index, juice contents, metal ions, firmness, vitamin C and storage capacity contents are to be compared in processing tomatoes grown by conventional production systems and organic production systems.

Materials and Methods

Materials

The F1 hybrid of tomatoes seeds was bought from Dharan, Sunsari which were produced and marketed by Syngenta India Ltd. to grow in Dharan-16, near Samichowk of Dharan Sub-metropolitan city,Sunsari. The seeding was done. The plants were transplanted after one month. The farming was done by taking five plants in two ways: Organic tomatoes farming and conventional tomatoes farming. For conventional farming, the seeds of tomatoes were planted by using urea whereas for organic farming, the seeds of tomatoes were planted by using goat manure and plant leaves as shown in Fig.1. The samples were ready for analysis after 5 months of plantation. The taste of organic edible fruits were sour where as that of conventional were sweet & sour. These edible fruit of tomatoes were the samples for analysis of different parameters. The samples were tested in different laboratories (Chemistry Lab. in Sunsari Technical College, Dharan-4, Nepal, Nepal Environmental Service Centre, Biratnagar, Nepal, and Department of Food Technology and Quality Control, Babarmahal, Kathmandu Nepal).

Fig. 1: Tomatoes farming (A. Conventional farming, B. Organic farming**)**

Methods

10 Tomato samples were collected. Determination of refractive index was carried out by a refractometer. The determination of metals in tomato was measured by Atomic absorption spectroscopy (AAS). The viscosity and surface tension was also determined.

In order to measure different parameters like surface tension, viscosity and refractive index, amount of metals like P, Mg, K, Ca and heavy metals like Zn, Mn, Ni , Pb, and Fe as well as the size of tomatoes, color, juice contents etc. for both conventional and organic tomatoes. It was taken equal amount of organic and conventional tomatoes. Both organic and conventional tomatoes were cut with small pieces and kept separately in the oven for drying up to temperature 80ºC. Drying was continued up to 50 hrs. After then temperature was increased up to 300ºC for approx one hour. The samples were dried till black, grinded and made powder. The equal amount of powder was kept in separate dry clean beaker and added equal amount of distilled water in both beaker. The tomato juice was filtered with filter paper in separate beaker. The residue was removed and filtrate was used for measuring the surface tension and viscosity of both tomatoes juice.

For density calculation of tomatoes juice, the equation (1) was used.

$$Density\ of\ liquid = \frac{wt.of\ the\ liquid}{wt.of\ equal\ volume\ of\ distilled\ water} \times Density\ of\ water\ at\ t°\mathrm{C}$$

The relative density is the weight of a given volume of liquid divided by the weight of an equal volume of water at the same temperature.

$$\rho = \frac{w_3 - w_1}{w_2 - w_1} \text{ x Density of water at } t°\mathrm{C} \ldots\ldots\ (1)$$

Where w_1=Wt. of empty density bottle.

w_2=Wt. of the bottle + distilled water.

w_3=Wt. of the bottle + Liquid (Solution)

t^0C= Temperature of experiment

$$\frac{w_3 - w_1}{w_2 - w_1} = \text{Relative density}$$

The surface tension and viscosity were calculated at 32℃ temperature.

The viscosity of a liquid is determined with respect to that of distilled water. This is called relative viscosity. Let t_1 and t_2 be the times of flow of fixed volume v of the two liquids through the same capillary.

The equation used for the calculation of viscosity is given below

$$\frac{\eta_1}{\eta_2} = \frac{d_1 t_1}{d_2 t_2} \text{.......................................} \quad (2)$$

Thus by determining the densities and the times of flow of the two liquids, the coefficient of viscosity of one of them can be easily calculated, provided the coefficient of viscosity of the other liquid.

The relative viscosity coefficient is calculated from the expression:

$$\frac{\eta}{\eta_w} = \frac{\mathrm{d}t_1}{d_w t_2} \text{ or } \eta = \frac{\eta_w \mathrm{d}t_1}{d_w t_2} \text{.......................} \quad (3)$$

Knowing the value of viscosity coefficient of water (η_w) at the temperature of the experiment, the absolute viscosity coefficient (η) of the given liquid can be found.

The drop weight method for determination of surface tension is based on the principle that the weight of a liquid falling from a capillary tube held vertical is approximately proportional to the surface tension of the liquid.If the surface tension of two liquids be γ_1 and γ_2 and w_1 and w_2 be the mean weight of their drops falling from the same capillary tube.

Let us suppose the number of drops of the two liquids be n_1 and n_2 for the same volume V of the liquids. Then

$$w_1 = \frac{V}{n_1} d_1$$
$$w_2 = \frac{V}{n_2} d_2 \quad \text{................................}(4)$$

Where d_1 and d_2 are the respective densities of the liquids.

Hence,

$$\frac{\gamma_1}{\gamma_2} = \frac{\frac{V d_1}{n_1}}{\frac{V d_2}{n_2}} = \frac{\frac{d_1}{n_1}}{\frac{d_2}{n_2}} \text{ ....}(5)$$

If the surface tension of one of the liquids is known then that of the other can be easily calculated from equation (5).

Procedure for operating Atomic absorption spectroscopy in determination of metals:

1. 10 g ground sample was transferred into ashing vessel.
2. The sample was charred in muffle, then ashed at 500°C overnight.
3. The ash was redissolved in 20 ml 2N HCl.
4. The ash was filtered through fast paper into 100 ml volumetric flask, washing paper and residue thoroughly with water. It was diluted into 100 ml.
5. The absorption of solution was measured directly. At least 4 standard solutions was read within analytical range before and after each group of 6 to 12 samples.
6. The calibration curve was done from average of each standard before and after sample group.

Results and Discussion

From the experiment, the following data has been obtained and are as follows:

The weight of conventional tomatoes juice = 50.69 g.

The weight of organic tomatoes juice = 50.613 g.

The weight of distilled water = 50.61g.

It was obtained by the experiment for viscosity measurement,

Time flow for organic tomatoes juice: 19 sec

Time flow for conventional tomatoes juice: 18 sec

Time flow for distilled water: 20 sec

Viscosity in organic tomatoes: $7.609\text{x}10^{-3}$ poise

Viscosity in conventional tomatoes: $7.220\text{x}10^{-3}$ poise

The nature of juice of organic tomatoes has found to be more viscous than conventional tomatoes juice.

It was obtained by the experiment for surface tension measurement,

No of drops for conventional tomatoes juice: 130

No of drops for organic tomatoes juice: 124

No. of drops for distilled water: 128

Surface tension in conventional tomatoes: 70.353 dyne/cm

Surface tension in organic tomatoes: 73.645 dyne/cm

The nature of juice of organic tomatoes has found to be more surface tension than conventional tomatoes juice.

The size of the organic tomatoes was smaller than conventional tomatoes as shown in Fig.2. Organic tomatoes were dark red colour than conventional tomatoes. It was observed that colour in conventional tomatoes were faint red

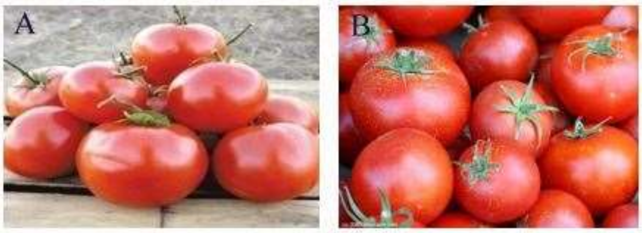

Fig. 2: Variation in size of tomatoes; A. Conventional; B. Organic

It was obtained by the experiment for refractive index measurement.

Refractive index in conventional tomatoes: 2.5 Brix

Refractive index in organic tomatoes: 2.9 Brix

The result of total suspended solid (TSS) by using refractometer is given below:

Total suspended solid (TSS) in conventional tomato: 5.3%

Total suspended solid (TSS) in organic tomato: 5.3%

It was obtained by the experiment for acidity measurement,

P^H in conventional tomatoes juice: 4.7

P^H in organic tomatoes juice: 5.1

The Table 1 shows the comparative studies of organic and conventional tomatoes farming in the parameters as TSS, refractive index, surface tension, viscosity, pH , Vitamin C, color , size, juice contents, storage capacity and firmness.

The calibration curve for the determination of heavy metals of both tomatoes (conventional and organic) by using Atomic absorption spectroscopy are given in Figs. 3 to 6.

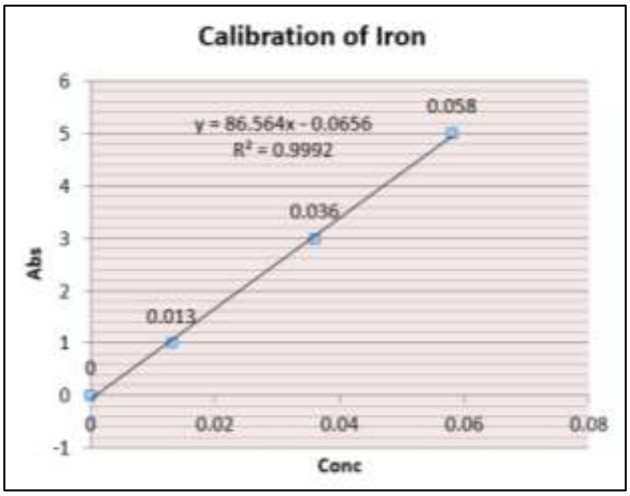

Fig. 3: Variation of Absorbance versus Concentration

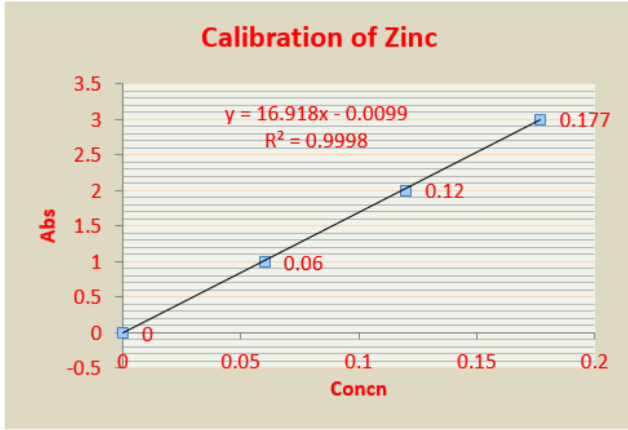

Fig. 4: Variation of Absorbance versus Concentration

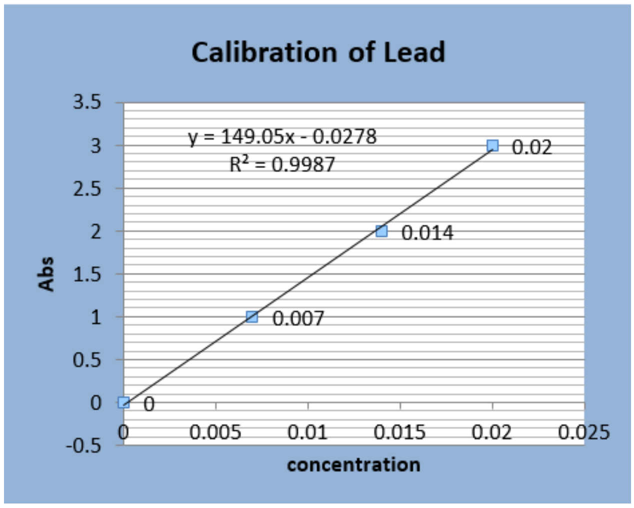

Fig. 5: Variation of Absorbance versus Concentration

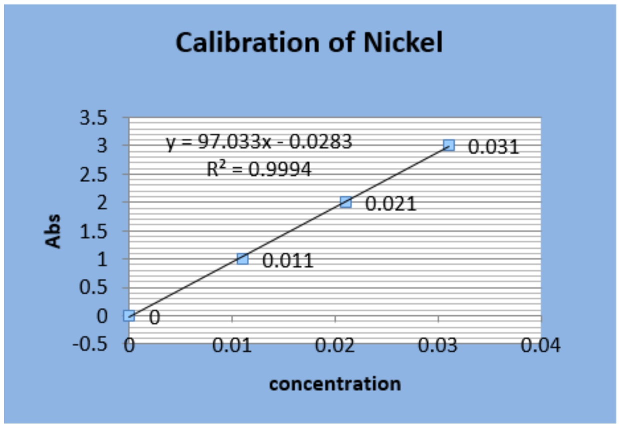

Fig. 6: Variation of Absorbance versus Concentration

According to test of AAS in Environmental Service Centre Lab., Biratnagar, Morang, Nepal the metals like Potassium, Calcium and Magnesium were present maximum amount in organic tomatoes than conventional tomatoes juice. Also, the heavy metals like Copper was present higher amount in organic tomatoes than conventional tomatoes whereas the heavy metal like Iron was present lower amount in organic tomatoes than conventional tomatoes. The Zinc was found to be same amount in both organic and conventional production tomatoes. Lead and Nickel could not be detected in both organic and conventional tomatoes (Table 2).

Table 1: Comparison among TSS, refractive index, surface tension, viscosity, pH, Vitamin C, colour, size, juice contents, storage capacity and firmness for organic and conventional tomatoes.

Results for organic tomatoes	Results for conventional tomatoes
Total suspended solid (TSS) : 5.3%	Total suspended solid (TSS) : 5.3%
Refractive index : 2.9 Brix	Refractive index: 2.5 Brix
Surface tension : 73.645 dyne/cm	Surface tension: 70.353 dyne/cm
Viscosity : 7.609×10^{-3} poise	Viscosity: 7.220×10^{-3} poise
P^H: 5.1	P^H: 4.7
Vitamin C : 26 mg/100g	Vitamin C :28 mg/100g
Colour : Dark Red	Colour : Faint Red
Size : Smaller	Size: Bigger
Juice contents : Maximum	Juice contents : Medium
Storage capacity : 9 days	Storage capacity : 7 days
Firmness : More	Firmness : Less

Table 2: The data obtained from farming

S.N.	Test Parameters	Test Methods	Units	Results	
				Organic	Conventional
1	Fe	AOAC 975.03	mg/100g	0.86	1.04
2	Zn	AOAC 975.03	mg/100g	0.12	0.12
3	Pb	AOAC 975.03	mg/100g	ND	ND
4	Ni	AOAC 975.03	mg/100g	ND	ND
5	Mn	AOAC 975.03	mg/100g	8.73	3.41
6	Mg	Titrimetric	mg/100g	953.27	426.96
7	Ca	Titrimetric	mg/100g	377.53	181.60
8	K	AOAC 975.03	mg/100g	3031.15	2311.05
9	Cu	AOAC 975.03	µg /kg	180.63	72.83

ND: Not Detected

Our organic tomatoes achieved significantly greater concentrations of minerals. Such greater concentrations of minerals were found in the literature for organic tomatoes (Kelly and Bateman, 2010).

We have found significantly greater concentrations of K, Ca, Cu and Mg in organic tomatoes and greater concentrations of Fe in conventionally grown tomatoes. Our findings matched with the literature (Ilić *et al.*, 2013).

The calcium content in the organic tomatoes (377.53 mg/100 g) in our research found to be higher than in conventional tomatoes (181.60 mg/100 gm). But the calcium concentrations for organic tomatoes (15.97– 23.13 mg/100 g) were higher in the reported literature (Ordonez-Santos *et al.*, 2011).

The lead content of tomato fruit, in general, was very low and ranges depending on the hybrid and the methods of production from 0.07 to 0.19 mg/ 100g (Kapoulas *et al.*, 2011). But we found nil result of Lead in both tomatoes.

Vitamin C from organic tomatoes farming has been found to be low (26 mg/100g) in comparison with conventional tomatoes (28mg/100g). Such high Vitamin C in organic tomatoes trends have been found in the literature (Lundegardh and Martensson, 2003; Borguini and Torres, 2006). It was also found that fertilizer that was rich in soluble nitrogen (N) could cause a decrease in the ascorbic acid content.

We can say that organic tomatoes were dark red color than conventional tomatoes due to presence of more carotene in organic production tomatoes than conventional production tomatoes. The juice of organic tomatoes has found to be more surface tension than conventional tomatoes juice due to more force of interaction between metals or other particles present in the organic tomatoes juice. So, number of drops of organic tomatoes is minimum than conventional production tomatoes juice and the nature of juice of organic tomatoes has found to be more viscous than conventional tomatoes juice due to presence of more amount of minerals, vitamins and some other constituent particles. The organic production tomatoes juice was more concentrated than conventional production tomatoes juice. So, it moves slowly due to more retarding force present in organic production juice.

Refractive index of organic tomatoes juice has greater value than conventional tomatoes juice.

Organic and inorganic fertilizer also influences the element present in the tomatoes. Organic production increases yields and builds soil quality. The organically farmed soils exhibited higher potential denitrification rates, greater denitrification efficiency, higher levels of organic matter, and greater microbial activity than the conventionally farmed soils.

Conclusions

The following conclusions have been drawn from the above results and discussion. Potassium, calcium and magnesium were present in high quantity in organic production tomatoes than in conventional production tomatoes. The Iron present was low in organic production tomatoes than in conventional production tomatoes. Copper present was high amount in organic production tomatoes than in conventional production tomatoes. Vitamin C present was low in organic production tomatoes than in conventional production tomatoes. Lead was not detected in both samples of tomatoes. The size of organic tomatoes was found to be smaller than conventional tomatoes. The surface tension and viscosity value of organic tomatoes juice was found to be of higher value than conventional tomatoes juice. The refractive index value was higher in organic tomatoes juice than in conventional tomatoes juice. Therefore, it can be concluded that organic tomatoes contain more nutritional value than conventional tomatoes.

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