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Analysis of oxalate of fresh and stored tomato juice

Devshikha*, Nitya Priyadarshi*, Sukriti Rani Prasad**
*B.Sc. –II year (2008-2011), Department of Botany, Patna Women's College, Patna University
**Lecturer (Guest faculty), Department of Botany, Patna Women's College, Patna University

Tomatoes are most widely used vegetable in daily life. Fresh ripe fruits of tomatoes are refreshing appetizing and are consumed raw in salads or after cooking. Unripe fruits are cooked and eaten. Tomatoes are consumed also in the form of juice, paste, ketchup, sauce, soup and powder.

According to latest studies in nutritional chemistry red tomatoes raw nutritional value per 100 gm (3.5 oz) contains ***20 kcal, carbohydrate - 4 gm, sugar – 2.6 gm, dietary fibre – 1 gm, fat – 0.2 gm, protein – 1 gm, water – 95 gm, vitamin C – 13 gm.*** *It also contains minerals like* ***calcium – 48 gm, phosphorous 20 –gm, iron – 0.4 gm, small amount of vitamin B complex.*** *The tomato is essentially an alkaline vegetable, its acid taste is due to* ***malic acid*** *which is about 0.5% it also contains 0.52& to 1.81* ***citric acid*** *and only a trace of* ***oxalic acid*** *is present. These acids in tomatoes, in combination with sodium and potassium either form sodium or potassium acid malate, citrate or oxalate. Their end products when oxidized in the body are carbon dioxide, water and the carbonates of potassium and sodium. The latter has alkaline reaction. Tomatoes thus leave an alkaline ash in the process of oxidized by the body. This increases the alkalinity of the blood and decreases the urine and neutralizes the acid compounds of the body such as phosphates, urea and ammonia. It is, therefore, highly beneficial in the treatment of acidosis and other diseases associated with too much acid in the system. The presence of oxalate ions and oxalic acid content in tomatoes is also a cause of kidney stones. Several researches have proven that the absorption of dietary oxalate is a major contribution on urinary stones. To avoid the risk of formation of kidney stones, it is, therefore, recommended that people should limit the intake of oxalate ions and calcium to bind whatever oxalate is ingested. A daily intake of 800-1200 mg of calcium per day for an adult is recommended by physicians to prevent stone formation.*

Accurate information on the oxalate contents of food is much harder to come due to difficulties in measuring it. The oxalate ions present in tomato fruit juice is measured by titration methods.

The study helped to analyze of tomato fruit juice on health. The study showed contribution of tomato fruit juice in the formation of stone. This study also showed that the consumption of fresh tomatoes is much beneficial than the consumption of stored tomatoes. The estimation of oxalate level in the fruit juice will be done by titration against standard potassium permanganate and standard sodium hydroxide solution. Difference in the volume of potassium permanganate and sodium hydroxide consumed will correspond to the total oxalate.

Key words*: Tomato, oxalic acid, oxalate ion, titration, sodium hydroxide, potassium per magnate.*

Introduction : Tomato is one of the world's most popular and widely cultivated fruit vegetable. Fresh ripe fruits of tomatoes are refreshing appetizing and are consumed raw in salads or after cooking. Unripe fruit area cooked and eaten. Tomatoes consumed area also in the form of juice, paste, ketchup, sauce and powder.

Ripe tomatoes with bright red colour and high acidity are used for the expansion of juice. It is sometimes seasoned to produce cocktail known as Tomato juice cocktail. Tomato juice is a nourishing beverage. It is prepared by dehydrating the juice.

Tomato is rich in calcium, phosphorus, vitamin C and carbohydrate. According to latest studies in nutritiona chemistry red tomatoes raw nutritional vale per 100 gm (3.5 oz) contains **20 kcal, carbohydrate - 4 gm, sugar**

– 2.6 gm, dietary fibre – 1 gm, fat – 0.2 gm, protein – 1 gm, water – 95 gm, vitamin C – 13 gm. It also contains minerals like **calcium – 48 gm, phosphorous 20 –gm, iron – 0.4 gm, small amount of vitamin B complex.** The tomato is essentially a vegetable. Its sour taste is due to **malic acid** which is about 0.5% it also contains 0.52 to 1.81% **citric acid** and only a trace of **oxalic acid** is present. These acids in tomatoes, in combination with sodium and potassium either from sodium or potassium aclid malate, citrate or oxalate. Their end products when oxidized in the body are carbon dioxide, water and the carbonate of potassium and sodium. The latter has alkaline reaction. Tomatoes thus leave an alkaline ash in the process of oxidization by, the body. This increases the alkalinity of the blood and decreases the urine and neutralizes the acid compounds of the body such as phosphates, urea and ammonia. It is therefore highly beneficial in the treatment of acidosis and other diseases associated with too much acid in the system.

The presence of oxalate ions and oxalic acid content in tomatoes is also a cause of kidney stones. Several researches have proven that the absorption of dietary oxalate is a major contribution to urinary stones. To avoid the risk of formation of kidney stones it is therefore recommended that people should limit the intake of oxalate ions and consume calcium to bind whatever oxalate is ingested. A daily intake of 800-1200 mg of calcium per day for an adult is recommended by physicians to prevent stone formation. Accurate information on the oxalate contents of food is much harder to come due to difficulties in measuring it. The oxalate ions present in tomato fruit juice measured by titration methods.

Materials and Methods :

The material those were required for the research project was:

Apparatus: Beaker, Conical Flask, Funnel, Filer paper, Burette, Pipette, Measuring cylinder, Burette stand, pH. Meter, Electronic weighing machine, Glass Bottle, Butter paper, Tissue paper.

Chemicals: $KMnO_4$ (Potassium permanganate), Sulphuric acid, Phenolphthalein, NaOH (sodium hydroxide), Distilled water.

Extraction of tomato juice :

Fresh ripen tomatoes were picked from the fields of Patna region. Some of the tomatoes were stored at 4^0 C for 1 week some of the tomatoes were crushed and juice was taken out. The juice was then filtered using cotton cloth so that the epicarp and seeds were removed. Bottles were marked as **F** and **S** for **"fresh"** and **"stored"** juice respectively. Juice from fresh tomatoes was put in bottles marked F_1,F_2,F_3 and juice from stored tomatoes was marked S_1,S_2,S_3.

First experiment sample marked as F_1 and S_1

Second experiment sample marked as F_2 and S_2

Third experiment sample marked as F_3 and S_3

The **F** marked juice was used for the experiment on the same day.

Measuring the pH of the samples

The pH was measured with the help of pH meter.

The bulb of pH meter was cleaned with tissue paper.

The pH meter was standardized with the buffer solutions of pH 4 and pH 7.

The bulb of pH meter was then dipped in the fresh and stored tomato juice samples and reading was noted. Each sample was tested one by one.

The findings were as follows:

pH of sample F1, F2, and F3 was 4.1

pH of sample S1, S2 and S3 was 4.3

The pH of **fresh tomato juice** was **4.1** and that of **stored tomato juice** is **4.3**

Dilution of fresh tomato juice :

25 ml of tomato juice sample was pipette out in a beaker.

After that 225 ml of distilled water was measured in measuring cylinder.

Then it was added in the beaker which already contained 25 ml juice.

Thus dilution of fresh tomato juice was done.

Likewise, the dilution of all the juice sample was done.

Dilution of the juice leads to a more homogeneous solution for better quantitative analysis.

Titration of fresh tomato juice (N/10) $KMnO_4$ solution form the prepared diluted juice **25 ml** was pipette out and transferred in a conical flask. **50 ml** distilled water was measured and poured in the diluted juice. **40 ml** bench sulphuric acid was also added in it. Thus a solution containing diluted juice, distilled water and bench sulphuric acid was prepared. The solution was mixed with glass tod and was heated at 70 degree centigrade. The (N/10) $KMnO_4$ solution was filled in the burette. The hot tomato juice solution was titrated against the Potassium permanganate solution.

The initial burette reading was noted. The end point of the reaction was the moment at which the persistent pink colour appeared in the conical flask. The final burette reading was noted.

The experiment was repeated for each of the samples.

Titration of fresh tomato juice against (N/10) NaOH

25 ml diluted juice was pipette out in a conical flask 1-2 drops of phenolphthalein was added as an indicator to the solution. The (N/10) Na OH solution was filled in the burette. Initial burette reading was noted.

The dilute juice was then titrated against (N/10) NaOH solution till end point was reached. It was the moment when a persistent faint red colour was appeared in the flask.

The final burette reading was noted.

Dilution of stored tomato juice

The tomato juice which stored at + 4 degree Celsius for 1 week taken out for analysis. 25 ml of stored tomato juice sample was pipette out in a beaker. After that 225 ml of distilled water was measured in measuring cylinder. Then it was added in the beaker which already contained 25 ml juice. Thus dilute tomato juice was obtained. Likewise, the dilution of all the three juice sample S_1, S_2 and S_3 was done.

Dilution of the juice leads to a more homogeneous solution for better quantitative analysis.

Titration of stored tomato juice against N/10 $KmnO_4$ Solution

From the prepared diluted juice **25 ml** was pipette out and transferred in a conical flask. **50 ml** distilled water was measuring and poured in the diluted juice. **40 ml** bench sulphuric acid was also added in it.

Thus a solution containing diluted juice, distilled water and bench sulphuric acid was prepared. The solution was mixed with glass rod and was heated at 70^0 C.

The (N/10) $KmnO_4$ solution was filled in the burette.

The hot tomato juice solution was titrated against the Potassium permanganate solution. The initial burette reading was noted. The end point of the reaction was the moment at which the persistent pink colour appeared in the conical flask. The funnel burette reading was noted. The experiment was repeated for each of the samples.

Titration of stored tomato juice against (N/10) NaOH

25 ml diluted juice was pipette out in a conical flask.

1-2 drops of phenolphthalein was added as an indicator to the solution. The (N/10) NaOH solution was filled in the burette. Initial burette reading was noted.

The dilute juice was then titrated against (N/10) NaOH solution till point was reached. It was moment when a persistent faint red colour was appeared in the flask. The final burette reading was noted.

Reactions

$C_2O_4^{2} + [O] \rightarrow CO_3^{2-} + CO_2$

(Oxalate ion) **Or**

$5C_2O_4^{2-} + 16H^+ + 2Mn\ O_4 \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

The nascent oxygen [O] comes form acidified KMnO4. The reaction was carried out at about 70°C gas out of the reaction mixture.

$2NaOH + H_2C_2O_4 \rightarrow Na_2C_2O_4 + H_2O$

(Oxalic acid)

Oxalate ions comes from two sources:- a) from salts sodium oxalate Or potassium oxalate & b) from the dissociation of oxalic acid

$H_2C_2O_4 \rightarrow C_2O_4^{2-} + 2H^+$

(Oxalic acid) **(Oxalate ion)**

Observation: Table1: Showing titration against (N/10) NaoH

S. No.	Volume of juice (ml)	Sample	Volume of (N/10) NaOH consumed	Indicator
1.	25	Fresh juice	4.5	Phenolphthalein
2.	25	Stored juice	3.6	Phenolphthalein

Table2: Showing titration against (N/10) $KMnO_4$

S. No.	Volume of juice (ml)	Sample	Volume of (N/10) $KMnO_4$ consumed	Indicator
1.	25	Fresh juice	4.5	Self indicator
2.	25	Stored juice	3.6	Self indicator

Calculation of oxalate ions content in fresh tomato juice:

By performing the experiments it was found that:

(1) 25 cc dilute juice requires 13.6cc (N/10) $KMnO_4$

Therefore, 250 cc dilute juice = 13.6cc (N) $KMnO_4$

Volume of $KMnO_4$ consumed corresponds to both oxalic acid and oxalate.

i.e. 250 cc diluted juice = 13.6cc oxalic acid + oxalate ion

Since, 250 cc of dilute juice contain the same amount of oxalic acid and oxalate which is present in the 25 cc of original fresh juice

So, **25 cc of original juice contains 13.5cc (N) oxalic acid and oxalate**

(2) 25 cc diluted juice requires 4.5cc (N/10) NaOH

Therefore, 250cc diluted juice = 4.5cc (N) NaOH

Volume of NaOH consumed corresponds to the oxalic acid.

i.e. 250 cc diluted juice = 4.5cc (N) oxalic acid

Since, 250cc of diluted juice contain the same amount of oxalic acid which is Present in the 25cc or original fresh juice.

So, 25 cc of original juice contains 4.5cc (N) oxalic acid.

The amount of oxalate in 25cc of original juice = [13.6-4.5] cc (N) = 9.1cc (N) oxalate thus the strength of oxalate ions in fresh tomato juice was found to be 9.1cc (N) oxalate ions.

Calculation of oxalate ions content in stored tomato juice:

By performing the experiment it was found that:

(1) 25cc dilute juice requires 17.5cc (N/10) $KMnO_4$

Therefore, 250 cc dilute juice = 17.5cc (N) $KMnO_4$

Volume of $KMnO_4$ consumed corresponds to both oxalic acid and oxalate.

i.e. 250 cc dilute juice = 17.5cc (N) oxalic acid + oxalate ions

Since, 250cc of diluted juice contain the same amount of oxalic acid and oxalate which is present in 25 cc of original fresh juice

So, 25 cc of original juice contains 17.5cc (N) oxalic acid and oxalate

(2) 25cc dilute juice requires 3.6cc (N/10) NaOH

Therefore, 250cc diluted juice = 3.6cc (N) NaOH

Volume of NaOH consumed corresponds to the oxalic acid.

i.e. 250cc diluted juice requires 3.6cc (N) oxalic acid

Since, 250cc of diluted juice contain the same amount of oxalic acid which is present in the 25cc of original fresh juice.

So, 25cc of original juice contains 3.6cc (N) oxalic acid.

The amount of oxalate in 25cc of original juice = [17.5-3.6] cc (N) = 13.9cc (N) oxalate

Thus the strength of oxalate ions in stored tomato juice was found to be 13.9cc (N) oxalate

Results and Discussion :

The calculations showed that oxalate ion content was increased in the samples S_1, S_2 and S_3. There was an increase of 4.8cc (N) [13.9cc(N) -9.1cc (N) oxalate] oxalate in the stored tomato juice samples. Only one week storage of tomato fruits at +4 degree Celsius there was an increases in the amount of oxalate ions. In combination with the calcium, the oxalate ion crystallizes to from kidney stones. Small pebbles of calcium oxalate that form in either the kidney or bladder passes out of the body without being noticed. However, if too large they can cause sever pain obstruction of flow of urine and sometimes infection in the urinary tract. So, intake of large amount of oxalate is always health hazardous. Since oxalic acid binds with vital nutrients such as calcium, long-term consumption of foods in moderation, but those with kidney disorders, gout, osteoporosis or rheumatoid arthritis are typically advised to avoid foods high in oxalic acid or oxalates. Oxalic acid oxalate requires excessive energy for it be metabolized. If too much oxalic acid is consumed then the body will begin to actually loose the nutrients.

Conclusion :

It is always beneficial to consume fresh tomatoes as its juice contains lesser oxalate. As a high oxalate level in food increases the risk formation of kidney stones.

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