Identification of Suitable Solvent System for Efficient Extraction of Lycopene from Tomato Pomace

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Abstract
Tomatoes have been traditionally credited as rich source of carotenoids. Tomatoes and tomato products are the major sources of lycopene compounds which can represent more than 85% of all the carotenoids present in the fruits. Tomato skins can be a viable source of lycopene. Industrial production of lycopene from tomatoes appears to be in high demand by food companies for the development of functional foods. Majority of companies that are into the business of manufacturing fruit extracts, prefer conventional solvent extraction method. Solvent extraction is extremely efficient with non-polar carotenoids (lycopene and β-carotene) with a total of carotenoids recovery of 96%. For identification of the suitable solvent system for efficient extraction of lycopene from tomato pomace, both polar and non polar solvents (acetone, ethanol, ethyl acetate, hexane and petroleum ether) were selected. The extract was analyzed for its lycopene content using UV-Vis Spectrophotometer. Acetone-Ethyl acetate was identified as the suitable solvent system for efficient extraction of lycopene from tomato pomace. The extraction carried out using Hexane, Petroleum ether and Hexane-Petroleum ether as the solvent system had the minimum lycopene content in the extract.

Keywords: Lycopene extract, Solvent extraction, Tomato pomace.

1. Introduction
Tomato (*Lycopersicon esculentum*) is used mainly as a vegetable both in fresh as well as in processed forms, in food preparations. More than 80% of processed tomatoes produced are consumed in the form of tomato juice, paste, puree, catsup and sauce (Gould, 1992). Tomatoes have been traditionally credited as rich source of carotenoids and vitamins, particularly lycopene, β-carotene, pro-vitamin A and vitamin C (Hanson *et al.*, 2004; Shi and Maguer, 2001).

Lycopene is an important carotenoid in tomatoes, responsible for its red colour (Rao and Agarwal, 2000). Tomatoes and tomato products are the major sources of lycopene compounds which can represent more than 85% of all the carotenoids present in the fruits. The antioxidant capability of lycopene has led to promising results in decreasing the risk of some illness and cancers (Delgado and Paredes, 2003). Animals and humans do not synthesize lycopene, and thus depend on dietary sources (Shi and Maguer, 2000).

Tomato skins can be a viable source of lycopene, as the per unit mass of tomato skins contain about five times more lycopene than the whole tomato pulp. Considering that more than one third of the tomatoes delivered to processing plants end as processing wastes, mainly constituted by seeds and skins, the recovery of this carotenoid could represent an alternative for the valorization of the by-products of the tomato industry (Sharma and Manguer, 1996). By-products and waste materials from the food processing industry can be a money-spinner if they are appropriately utilized using newer knowledge and technologies (Potty, 2009). Presently, pomace (peels and seeds) from tomato processing industry is mechanically removed and discarded. This by-product is used for animal feed but it is not used for human consumption. It has high moisture content and incurs a drying expense in order to be preserved. Thus large quantity of carotenoids is lost as waste. Successful extraction technology for lycopene recovery from tomato pomace can significantly improve the economic aspects of tomato industry besides making available one of the most potent antioxidants for formulating health supplements for human beings. Industrial production of lycopene from tomatoes appears to be in high demand by food -
companies for the development of functional foods. High-purity lycopene can be obtained from tomato fruits by various purification and separation processes including solvent extraction (SE), super critical fluid extraction (SCFE), distillation, membrane separation, chromatography and crystallization. Majority of companies that are into the business of manufacturing fruit extracts, prefer conventional solvent extraction method. The main reason for the adoption of solvent extraction method is the cheaper cost of technology and better recovery as compared to other methods. This type of extraction is extremely efficient with non-polar carotenoids (lycopene and \( \beta \)-carotene) with a total of carotenoids recovery of 96% (Semedo et al., 2012).

A scientific study was undertaken to find out the effective solvent system for efficiently extracting lycopene from the fresh tomato pomace.

### 2. Materials and Methods

#### 2.1 Tomato Pomace

Fresh tomato pomace was procured in bulk from a tomato processing industry, M/S. Nirmal Foods Pvt Ltd, Virsad, Gujarat. The pomace, having around 80-85 % moisture content (w.b.) was bagged and stored at -20 \( ^\circ\)C in deep freezer until used for further analysis and experiments.

#### 2.2 Identification of Suitable Solvent System

Shaker water bath was used for solvent extraction of lycopene from tomato pomace. For identification of the suitable solvent system for efficient extraction of lycopene from tomato pomace, both polar and non polar solvents (acetone, ethanol, ethyl acetate, hexane and petroleum ether) were selected. Single solvent system, double solvent system (1:1) and triple solvent system (1:1:1) were used for experimental purpose. The experiments were carried out by placing 5 g weighed sample into iodine flask containing 150 ml of solvent system and then placing it on the flask rack of shaker water bath maintained at 35 \( ^\circ\)C for 1 h. The extract was then analyzed for its lycopene content using UV-Vis spectroscopy technique to select the suitable solvent system. After the solvent extraction of lycopene from tomato pomace, the solvents were distilled out. The remaining lycopene extract, after making up with required quantity of hexane was taken for measuring the lycopene content using UV-Vis spectrophotometer at 503 nm (Olives et al., 2006; Lavecchia and Zuorro, 2008; Naviglio et al., 2008). Completely Randomized Design was used for

### Table 1: Lycopene content in extract using different solvent systems

<table>
<thead>
<tr>
<th>Code</th>
<th>Solvent system</th>
<th>Lycopene content (mg/100 g)</th>
<th>Code</th>
<th>Solvent system</th>
<th>Lycopene content (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Hexane</td>
<td>0.54</td>
<td>T13</td>
<td>Acetone: Ethanol</td>
<td>3.52</td>
</tr>
<tr>
<td>T2</td>
<td>Petroleum ether</td>
<td>0.48</td>
<td>T14</td>
<td>Acetone: Ethyl acetate</td>
<td>7.91</td>
</tr>
<tr>
<td>T3</td>
<td>Acetone</td>
<td>3.79</td>
<td>T15</td>
<td>Ethanol: Ethyl acetate</td>
<td>8.02</td>
</tr>
<tr>
<td>T4</td>
<td>Ethanol</td>
<td>1.15</td>
<td>T16</td>
<td>Hexane: Petroleum ether: Acetone</td>
<td>3.25</td>
</tr>
<tr>
<td>T5</td>
<td>Ethyl acetate</td>
<td>1.18</td>
<td>T17</td>
<td>Hexane: Petroleum ether: Ethanol</td>
<td>2.91</td>
</tr>
<tr>
<td>T6</td>
<td>Hexane: Petroleum ether</td>
<td>0.52</td>
<td>T18</td>
<td>Hexane: Petroleum ether: Ethyl acetate</td>
<td>2.06</td>
</tr>
<tr>
<td>T7</td>
<td>Hexane: Acetone</td>
<td>1.25</td>
<td>T19</td>
<td>Hexane: Acetone: Ethanol</td>
<td>5.59</td>
</tr>
<tr>
<td>T8</td>
<td>Hexane: Ethanol</td>
<td>3.14</td>
<td>T20</td>
<td>Hexane: Acetone: Ethyl acetate</td>
<td>4.79</td>
</tr>
<tr>
<td>T9</td>
<td>Hexane: Ethyl acetate</td>
<td>1.08</td>
<td>T21</td>
<td>Hexane: Ethanol: Ethyl acetate</td>
<td>6.24</td>
</tr>
<tr>
<td>T10</td>
<td>Petroleum ether: Acetone</td>
<td>1.65</td>
<td>T22</td>
<td>Petroleum ether: Acetone: Ethanol</td>
<td>2.88</td>
</tr>
<tr>
<td>T11</td>
<td>Petroleum ether: Ethanol</td>
<td>2.75</td>
<td>T23</td>
<td>Petroleum ether: Ethanol: Ethyl acetate</td>
<td>3.28</td>
</tr>
<tr>
<td>T12</td>
<td>Petroleum ether: Ethyl acetate</td>
<td>1.05</td>
<td>T24</td>
<td>Acetone: Ethanol: Ethyl acetate</td>
<td>6.76</td>
</tr>
</tbody>
</table>
statistical analysis of the data for identification of suitable solvent system.

The data were recorded and the lycopene content (mg/100 g) was calculated using the following formula:

\[
\text{Lycopene content} = \frac{A_{503}}{a_{503}} \times \frac{v}{1000} \times \frac{100}{w}
\]

Where,

- \(A_{503}\) = absorbance noted at 503 nm
- \(a_{503}\) = specific extinction coefficient of lycopene in n-hexane (310.5)
- \(v\) = total volume of the solvent and extract, ml
- \(w\) = weight of the sample, g

### 3. Results and Discussion

The extract was analyzed for its lycopene content using UV-Vis Spectrophotometer as described above. All the experiments were done in triplicate and average value is reported in Table 1. Identification of the suitable solvent system was done on the basis of the highest lycopene content present in the extract of tomato pomace sample. The graphical representation of the solvent systems and lycopene content is shown in Fig 1.

Among all the solvent systems used, Acetone: Ethyl acetate (T14) and Ethanol: Ethyl acetate (T15) gave significantly higher lycopene content in the extract than the other solvent systems. The lycopene extracted using T14 and T15 solvent systems were found to be statistically at par and had the lycopene content of 7.91 mg/100 g and 8.02 mg/100 g, respectively. Hence, either of the two solvent systems can be used for efficient solvent extraction process. Acetone-Ethyl acetate (T14) was identified as the suitable solvent system because of the cost effectiveness and easy availability compared to ethanol.

The extraction carried out using Hexane, Petroleum ether and Hexane-Petroleum ether as the solvent system had the minimum lycopene content in the extract i.e., 0.54 mg/100 g, 0.48 mg/100 g and 0.52 mg/100 g in that order. It may be due to the non-polar nature of hexane and petroleum ether as the tomato pomace had very high moisture content.

![Fig 1: Effect of solvent systems on lycopene content in extract](image1)

![Fig 2: UV-Visible absorbance spectra of lycopene extract (Acetone:Ethyl acetate as the solvent system)](image2)
Table 2: Absorbance spectra of lycopene extract using Acetone: Ethyl acetate as the solvent system

<table>
<thead>
<tr>
<th>Repetitions</th>
<th>Absorbance (503 nm)</th>
<th>Lycopene content (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.625</td>
<td>7.90</td>
</tr>
<tr>
<td>2</td>
<td>0.651</td>
<td>7.86</td>
</tr>
<tr>
<td>3</td>
<td>0.643</td>
<td>7.97</td>
</tr>
</tbody>
</table>

The UV-Vis absorbance spectra of lycopene extract from wet tomato pomace by using Acetone: Ethyl acetate as the solvent system is shown in Fig 2 and the values are reported in Table 2.

4. Conclusions

The following conclusions can be drawn; Acetone: Ethyl acetate and Ethanol: Ethyl acetate (1:1) solvent systems resulted in the highest lycopene content in the extract when the extraction was carried out for 1h at 35 °C among all the solvent systems tested. The former solvent system (Acetone: Ethyl acetate) was selected because of the cost effectiveness and easy availability as the extraction was statistically at par. The extraction carried out using Hexane, Petroleum ether and Hexane-Petroleum ether as the solvent system had the minimum lycopene content in the extract i.e., 0.54 mg/100 g, 0.48 mg/100 g and 0.52 mg/100 g in that order. It may be due to the non-polar nature of hexane and petroleum ether as the tomato pomace had very high moisture content. Further studies can be carried out considering different parameters, i.e. time, temperature and feed to solvent ratio for optimizing extraction conditions for higher lycopene recovery from tomato processing waste.

References


Potty V (2009). By-products utilization can improve the economics of tomato industry. Processed Food Industry, CFTRI, Mysore. (http://vhpotty.blogspot.com)


