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Flotation-cum-sedimentation system for skin and seed separation from tomato pomace

Devinder Kaur [a], D.S. Sogi [a,*], S.K. Garg [b], A.S. Bawa [c]

[a] Department of Food Science and Technology, Guru Nanak Dev University, Amritsar 143 005, India
[b] Department of Molecular Biology and Biochemistry, Guru Nanak Dev University, Amritsar 143 005, India
[c] Defence Food Research Laboratory, Mysore, India

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Abstract

Skin and seeds were separated from the pomace in a newly designed and fabricated flotation-cum-sedimentation system consisting of one mixing tank, three settling tanks, a water-collecting tank and a recirculation pump. The dispersion time at various feed rates revealed that with the increase in pomace level from 5% to 20% the dispersion time also increased from 1.6 to 31.31 s. The system was operated at various feed (6–12 kg/min) rates and quality of the separated skin and seeds was evaluated. The separation efficiency increased from 58% to 71% for skin and 42% to 65% for seeds respectively as the feed rate varied from 12 to 8 kg/min. Results revealed that the system could be operated with a feed rate of 500 kg/h.

Keywords: Tomato; Pomace; Seeds; Skin; Separation system; Waste

1. Introduction

Tomato (*Lycopersicon esculentum*), is one of the most popular vegetables, used as a salad, in food preparations and as juice, soup, puree, ketchup or paste. Commercial processing of tomato produces a large amount of waste at various stages. Tomato pomace constitutes the major part of the waste that comes from the pulper. The wet pomace contained 33% seed, 27% skin and 40% pulp while the dried pomace contained 44% seed and 56% pulp and skin (Sogi & Bawa, 1998). Tomato seeds, the major component of pomace, contained a good quantity of proteins and lipids (Al-Wandawi, Rahman, & Al-Shaikhly, 1985; Brodowski & Geisman, 1980; Kramer & Kwee, 1977; Tsatsaronis & Boskou, 1975; Sogi & Bawa, 1998). The skin, another important component of pomace, was utilized for extracting the red pigment using organic solvents (Chandler & Schwartz, 1987; Heinonen, Ollilainen, Linkola, Varo, & Koivistoinen, 1989; Sadler, Davis, & Dezman, 1990; Tonucci et al., 1995). Lycopene is an excellent natural food color and also serves as a micronutrient with important health benefits. It provides protection against a broad range of epithelial cancers (Gerster, 1997; Levy et al., 1995; Micozzi, Beecher, Taylor, & Khachik, 1990). It is stable to heat and pH values encountered in food processing. It is effective at low concentrations and is free from off flavors. It covers the full range of colors from yellow through orange to deep red.

Unutilized wastes not only add to the disposal problem but also aggravate environmental pollution. Tomato skin and seeds needs to be separated from the pomace for their utilization as a natural color, protein and fat. In the present study, a pilot scale continuous system was designed, fabricated and evaluated for the separation of skin and seed from pomace.

* Corresponding author. Tel.: +91 183 2258802x3217; fax: +91 183 2258820.
E-mail address: dsogi@yahoo.com (D.S. Sogi).

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2. Materials and methods

2.1. Material

The pomace was collected from a tomato paste-manufacturing unit located in the Amritsar district during the processing season May 2003.

2.2. Separation system

A schematic diagram of the pilot scale floatation-cum-sedimentation system is shown in Fig. 1. It consisted of one mixing tank (T1) having an impeller with three paddles for mixing pomace and water, three settling tanks (T2–T4), three trays to collect seeds, skin and fibrous residues, one water collection tank (T5) and one recirculation pump (RP).

2.3. Mixing time

The time for desperation of pomace into water was estimated under static conditions. The mixing tank (T1) was filled with water and pomace was added at the rate of 5, 10, 15 and 20 kg/100 kg water. The mixing was carried out for 1–18 min by operating the impeller. The samples were drawn periodically and analyzed for skin content. The standard deviation was computed for every skin fraction and used to determine the mixing time. The mixing index (Fellow, 1985) was computed as follows:

$$M = \frac{\text{Log } S_1 - \text{Log } S_2}{\text{Log } S_0 - \text{Log } S_2} \tag{1}$$

where M is the mixing index, S_1 is the standard deviation for the sample, $S_2 = 0.01$ is the standard deviation under ideal conditions, S_0 is the $[C(1-C)]^{1/2}$ and C is the proportion of the skin in the waste.

The natural log of the mixing index was plotted against time and the mixing rate constant was found from the slope of the curve.

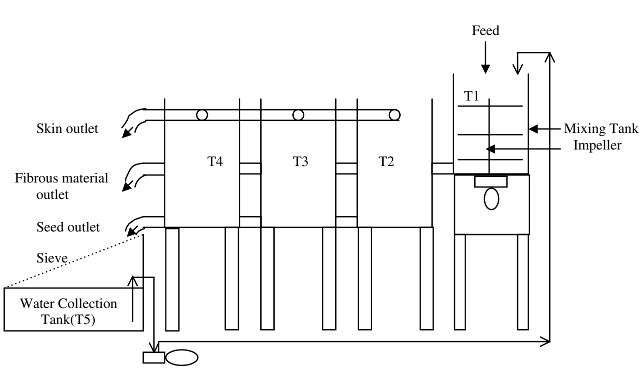

Fig. 1. Schematic diagram of flotation-cum-sedimentation system for skin and seed separation from tomato pomace.

$$t = \ln M/k \tag{2}$$

where t is the mixing time, and k is the mixing rate constant.

The values of 'k' was calculated and the mixing index (M) was computed assuming values of $S_1 = 0.011$. Mixing time (t) was computed by inserting the values of 'M' and 'k'.

2.4. Feed rate

Flotation-cum-sedimentation system was run and the pomace was added to the mixing tank (T1). The resultant mixture was moved on from (T1) to the series of settling tanks (T2–T4) where the seeds and skin were separated from the fibrous residues. The seeds settled to the bottom of the tanks and were collected from the lower outlet. The skin being lighter in weight floated at the top and was collected through the upper outlet. The system was operated at different feed rates for 10 min. The seed, skin and fibrous matter were weighed and the proportion of the skin and seeds were calculated. For skin, the separation efficiency was calculated as follows:

$$\eta = \frac{Px_{\text{P}}.R.(1-x_{\text{R}})}{F.x_{\text{F}}.F.(1-x_{\text{F}})} \times 100 \tag{3}$$

where η is the separation efficiency (%), F is the flow rate of the feed (kg/min), P is the flow rate of desired product (kg/min), R is the flow rate of rejection (kg/min), x_{F} is the mass fraction of desired product in feed, x_{P} is the mass fraction of desired product in product, and x_{R} is the mass fraction of desired product in rejection.

3. Statistical analysis

One-way analysis of variance (ANOVA) as well as least significant difference techniques were employed to ascertain the changes in 'k' and 't' with changes in pomace content (Gomez & Gomez, 1984).

4. Results and discussion

4.1. Mixing time

The pomace was mixed with water in the mixing tank and the mixing time was calculated for different levels of pomace. Samples collected showed low standard deviation for skin content at the beginning and then increase followed by a decrease. The pattern of standard deviation might be due to the fact that in the beginning pomace contained the same proportion of skin and seeds. Later the components started dispersing and seeds tended to settle down thus the standard deviation