Effect of Pulper-Finisher Specifications on Tomato Juice Characteristics

4 authors, including:

Ampawan Tansakul
King Mongkut's University of Technology Thonburi
32 PUBLICATIONS **502** CITATIONS

SEE PROFILE

Athapol Noomhorm
Asian Institute of Technology
116 PUBLICATIONS **3,028** CITATIONS

SEE PROFILE

Effect of Pulper-Finisher Specifications on Tomato Juice Characteristics

Ampawan Tansakul, Athapol Noomhorm, Sakarindr Bhumiratana and Nisit Patmayothin

The preparation of tomato puree involves size reduction, heating to soften the tissue and inactivate enzymes, and straining of the heated mass through a pulper-finisher. The juice from the pulper-finisher is then concentrated, sterilized and packaged.

The commonly used pulper-finisher consists of a horizontal cylinder made of a fine stainless steel sieve. Inside the cylinder are heavy paddles that rotate rapidly, forcing the fine pulp to pass through the screen and the pieces of skin, seeds, fibre, etc. pass out at the end of the machine (Luh and Kean, 1988). The quantity, configuration, and characteristics of the suspended particles also influence the viscosity of the product (Tanford, 1961; Hand, Moyer, Ransford, Hensing and Whittenberger, 1955; Robinson, Kimball, Ransford, Moyer and Hand, 1956; Luh and Daoud, 1971). Consistency depends largely on the .quantity, shape and degree of subdivision of the cell walls present, and on the characteristics of the walls (Whittenberger and Nutting, 1957). The finisher is important in controlling the gross viscosity of tomato juice. With a paddle-type finisher, adjustment of the speed of the paddle will provide a wide range of gross viscosity regardless of the preheating temperatures (Hand *et al.*, 1955). The speed and the screen size of the pulper-finisher considerably influence the gross viscosity of the juice. A larger screen size in the finisher gave a paste with a higher consistency (Smit and Nortje, 1958). It has also been found with similar studies on apple sauce that screen size and finisher speed can significantly influence consistency due to their effect on the quantity and dimensions of the pulp (Rao, Cooley, Nogueira and Mclellan, 1986). Pulp content and average particle size of the solids also affect the magnitude of the yield stress of apple sauce (Qiu and Rao, 1988). Conversely small screen sizes can affect the gross viscosity of tomato concentrates in two opposite manners. One is enhanced gross viscosity due to the large surface area of small particles and the other is diminished gross viscosity due to the exclusion of large particles (Tanglertpaibul and Rao, 1987).

Miss Ampawan Tansakul is at the Department of Food Engineering, King Mongkut's Institute of Technology Thonburi (KMITT), Bangmod, Ratburana, Bangkok 10140, Thailand. Dr Athapol Noomhorm is at the Division of Agricultural and Food Engineering, Asian Institute of Technology (AIT), Thailand. Dr Sakarindr Bhumiratana and Mr Nisit Patmayothin are at the Department of Chemical Engineering, King Mongkut's Institute of Technology Thonburi (KMITT), Bangmod, Ratburana, Bangkok 10140, Thailand.

Previous studies on concentrated tomato have focussed mainly on the thermobreak temperature, pH and method of concentration.

This paper summarises a study by Tansakul (1990) of different screen sizes and speeds of two pulper-finishers on total solids, pulp/serum ratio, particle size distribution and consistency of tomato juice.

Tomatoes (*Lycopersicon esculentum*.L., var VF-134) were harvested from the Royal Food Processing Project in Chiang Mai Province, Thailand. The tomatoes were sorted, washed and heated to 80°C before being fed into pulper-finisher at a rate of 1 kg/sec. The heated tomatoes were then crushed and extracted by the pulper-finisher operating at 100, 300, 500 or 700 rpm with screen openings of 0.5, 1.0 or 1.5 mm. In each trial, a tomato sample weighing 5 kg was retained in the pulper-finisher for 4 minutes. The juice from the pulper-finisher was evaporated at vacuum pressure of 60-62 cm Hg and water bath temperature of 70°C for 35 minutes. One pulper-finisher had two blades with no angle adjustment. The second had three blades with adjustable angle arrangement.

The following quality parameters were used:

- Yield of tomato juice from the pulper-finisher
- Total solids (A.O.A.C., 1975)
- Total soluble solids with an Atago refractometer (expressed as °Brix at 20°C)
- Acidity by titration of filtrate with 0.1 N NaOH using phenolpthalein as indicator (expressed as % anhy drous citric acid)
- pH using pH meter Model HM - 26S
- Consistency by Brookfield Viscometer at different rates of shear at 6, 12, 30 and 60 rpm (expressed as consistency index which is the pseudoplasticity coefficient and increases with increasing solids content of food). Consistency index can be computed by using Power Law Model (Heldman and Singh, 1981).
- Particle size distribution (Kimball, Lillan and Kertesz, 1952) (expressed as the weighted average diameter (mm) of the average particles present in each frac tion)

Data obtained through various tests conducted on two pulper-finishers was analyzed statistically through Analysis of Variance (ANOVA) and Multiple Range Test (MRT) using the STATGRAPHICS software package on a microcomputer.

The chemical and physical characteristics of fresh VF-134 tomatoes used in experiments with the two pulper-finishers are shown in Table 1.

Table 1. Chemical and physical analyses of fresh VF-134 tomatoes

Average weight per tomato fruit	70.5 ± 20 g
Total solids	6.15 ± 0.05%
Soluble solids	5.50 ± 0.10 Brix
pH	4.41 ± 0.02
Titratable acidity	0.20 ± 0.01% citric acid

Experiments using the 2-blade and 3-blade pulper-finisher showed the effect of different screen sizes (0.5, 1.0, 1.5 mm) and different speeds (100, 300, 500, 700 rpm) on total solids, particle size distribution, consistency index and yield of tomato juice (Tables 2 and 3).

For a given screen size, the higher the speed of the pulper-finisher, the higher the consistency of tomato juice.

At a given speed the greater screen size allowed not only more tomato pulp but also tomato serum to flow through the sieve which resulted in a higher yield of tomato juice.

When the number of blades was increased from two to three, the blade angles were adjusted to give the shape of a taper facilitating smooth flow of product in one direction and not allowing the product to remain in any one position for too long. Increasing the number of blades helped to push more product through the screen holes.

Yields, total solids of tomato juice, total solids of tomato puree and pulp/serum ratio of tomato juice obtained from the 3-blade pulper-finisher were higher than with 2 blades.

Particle size distribution was similar for both machines. The size of particles depended on the screen size through which the tomato pulp passed rather than the number of blades used.

Significant increases were observed for consistency index using the 3-blade unit for all the treatment combinations of pulper-finisher speed and screen size because of the higher total solids and higher pulp/serum ratio.

The operating combination of 1.0 mm screen size and speed of 700 rpm produced tomato juice and tomato puree of highest consistency for both pulper-finishers.

The screen size of 1.5 mm and speed of 700 rpm gave the highest yield for both pulper-finishers.

The 3-blade pulper-finisher, with a provision for blade-angle adjustment gave better quality and higher yield of tomato juice and tomato puree than the 2-blade pulper-finisher with no provision for blade-angle adjustment.

ACKNOWLEDGEMENT

Support from the Canadian International Development Agency/Asian Institute of Technology-Canadian Universities Consortium/Partnership Project (CIDA/AIT - CUC/PP) for this study is gratefully acknowledged.

REFERENCES

AOAC (1975)

Hand, D.B., Moyer, J.C., Ransford, J.R., Hensing, J.C. and Whittenberger, R.T. Effect of processing conditions on the viscosity of tomato juice. Food Technol. 9: 228-235; 1955.

Heldman, D.R. and Singh, R.P. Food process engineering. Westport, CT: AVI Publishing Co. Inc., 1981. 36-39.

Kimball, L.B., Lillan, B. and Kertesz, Z.I. Practical determination of size distribution of suspended particles in macerated tomato products. Food Technol. 6: 68-71; 1952.

Luh, B.S. and Daoud, H.N. Effect of break temperature and holding time on pectic enzymes in tomato pulp. J. Food Sci. 36: 1039-1043; 1971.

Luh, B.S. and Kean, C.E. Commercial vegetable processing. 2nd Edition. Westport, CT: AVI Publishing Co. Inc., 1988.

Qiu, C.G. and Rao, M.A. Role of pulp content and particle size in yield stress of apple sauce. J. Food Sci. 53: 1165-1170; 1988.

Rao, M.A., Cooley, H.J., Nogueira, J.N. and Mclellan, M.R. Rheology of apple sauce: effect of apple cultivar, firmness and processing parameters. J. Food Sci. 51: 176-179; 1986.

Robinson, W.B., Kimball, L.B., Ransford, J.R., Moyer, J.C. and Hand, D.B. Factors influencing the degree of settling in tomato juice. Food Technol. 10: 109-112; 1956.

Smit, C.J.B. and Nortje, B.K. Observation on the consistency of tomato paste. Food Technol. 12: 356-358; 1958.

Tanford, C. Physical chemistry of macromolecules. New York: John Wiley & Sons, 1961.

Tanglertpaibul, T. (nee Sornsrivichai) and Rao, M.A. Rheological properties of tomato concentrates as affected by particle size and methods of concentration. J. Food Sci. 52(1): 141-145; 1987.

Tansakul, A. Quality of tomato juice and tomato puree: effect of screen size and speed of pulper-finisher. Bangkok: Asian Institute of Technology, 1990. M.Sc. Thesis.

Whittenberger, R.T. and Nutting, G.C. Effect of tomato cell structures on consistency of tomato juice. Food Technol. 11: 19-22; 1957.

Table 2. Results from the 2-blade pulper-finisher*

Screen Operating		Yield	Particle Size Distribution of Tomato Juice (mm)	Total Solids of Tomato Juice (%)	Total Solids of Tomato Puree (%)	Pulp/ Serum Ratio of Tomato Juice (%)	Consistency Index of Tomato Juice (Pas'n)
Size (mm)	Speed (rpm)	(%)					
0.5	100	43.9 a	0.27 a	5.1 a	12.7 a	16.2 a	0.2 a
0.5	300	63.8 b	0.29 a	5.2 b	13.0 b	20.0 abc	0.3 a
0.5	500	67.2 bc	0.29 a	5.2 bc	13.8 c	20.0 abc	0.8 abc
0.5	700	72.5 bcd	0.28 a	5.3 d	14.9 f	20.4 abc	1.5 d
1.0	100	46.5 a	0.34 b	5.3 d	13.9 c	21.3 abc	0.5 ab
1.0	300	65.4 bc	0.35 bc	5.4 e	14.2 d	26.3 cde	1.2 cd
1.0	500	68.6 bc	0.37 cd	5.5 f	14.5 e	31.1 fg	3.8 f
1.0	700	73.6 cd	0.39 d	5.6 g	15.9 h	35.6 g	4.0 f
1.5	100	47.5 a	0.42 e	5.2 bc	12.8 a	17.6 ab	0.5 a
1.5	300	67.7 bc	0.42 e	5.2 cd	13.1 b	23.4 bcd	1.1 bcd
1.5	500	68.9 bc	0.46 f	5.4 e	14.2 d	28.6 def	1.4 d
1.5	700	78.2 d	0.47 f	5.5 f	15.3 g	31.0 efg	2.4 e

* means with the same letter in each column are not significantly different (P>0.95)

Table 3. Results from the 3-blade pulper-finisher*

Screen Operating		Yield	Particle Size Distribution of Tomato Juice (mm)	Total Solids of Tomato Juice (%)	Total Solids of Tomato Puree (%)	Pulp/ Serum Ratio of Tomato Juice (%)	Consistency Index of Tomato Juice (Pas'n)
Size (mm)	Speed (rpm)	(%)					
0.5	100	44.3 a	0.27 a	5.0 a	13.1 a	20.4 a	0.3 a
0.5	300	66.0 c	0.28 a	5.6 cd	13.3 b	23.4 b	0.5 ab
0.5	500	76.3 d	0.28 a	5.6 cde	13.9 d	28.7 de	1.5 de
0.5	700	78.2 de	0.29 a	5.8 efg	15.0 i	33.6 ef	1.8 ef
1.0	100	46.9 b	0.35 b	5.5 c	13.9 d	26.0 c	1.7 e
1.0	300	67.1 c	0.35 b	5.7 def	14.7 g	27.2 cd	2.2 fg
1.0	500	76.6 d	0.34 b	5.9 gh	14.9 h	32.2 fg	4.3 i
1.0	700	79.9 ef	0.34 b	6.1 i	16.2 k	37.2 i	4.8 i
1.5	100	47.6 b	0.42 c	5.2 b	13.5 c	23.5 b	0.8 bc
1.5	300	67.7 c	0.41 c	5.6 cd	14.2 e	26.7 cd	1.2 cd
1.5	500	76.8 d	0.42 c	5.8 fg	14.3 f	30.2 ef	2.5 g
1.5	700	80.9 f	0.43 c	6.0 hi	15.6 j	35.2 hi	3.1 h

* means with the same letter in each column are not significantly different (P>0.95)