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Storage of tomato powder in different packaging materials

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The study was conducted to find out suitable packaging materials for the storage of tomato powder having a good potential as the substitute of raw tomato pulp. The mature tomato slices were pretreated in salt solution of 1% calcium chloride ($CaCl_2$) and 0.2% potassium metabisulphite (KMS) for 10 minutes. The slices were dried at 60 ^{0}C for 26 hours in cabinet drier and milled into tomato powder. The tomato powder was packed in Laminated Aluminum Foil (LAF), High Density Polyethylene (HDPE), and Medium Density Polyethylene (MDPE) and stored for six months. It was observed that the moisture absorption by the tomato powder was lower through LAF (0.13%) as compared to the HDPE (1%) and MDPE (1.33%). The degradation rate of protein (4%) and fat (0.24%) of the powder through LAF was lower than that of HDPE (5.61% protein and 0.47% fat) and MDPE (5.76% protein and 0.52% fat). The loss of vitamin C (20.79 mg/100g), lycopene (17.15 mg/100g), and β-carotene (2852.55 µg/100g) was found in LAF pouch. On the contrary, the degradation of vitamin C (30.34 mg/100g and 29.25 mg/100g), lycopene (18.21 mg/100g and 17.89 mg/100g), and β-carotene (3810.09 µg/100g and 3279.66 µg/100g) was found in MDPE and HDPE respectively. Again, the microbial load in terms of bacteria (3.12×10^2) and fungi (7.87×10^2) in the tomato powder packed in LAF was only at acceptable level during the storage period of six months. Considering the results found it can be concluded that the tomato powder should be preserved for maximum 6 months in LAF at ambient temperature by applying pre-treatment with a salt solution of 1% $CaCl_2$ + 0.2% KMS prior to drying at 60 ^{0}C.

Keywords: Tomato, Tomato powder, Packaging materials, Storage study

Introduction

Tomato (*Lycopersicum esculentum*) is a globally known vegetable, belongs to the family Solanaceae. Tomato is also one of the most widely grown vegetable crops in Bangladesh and is easily grown in all agro-ecological zones of the country with average yield of 7.42 tons per hectare (Nahar *et al.*, 2011). Tomato is a rich source of lycopene (60-90 mg/kg), vitamin C (160-240 mg/kg), polyphenols (10-50 mg/kg) and small quantities of vitamin E (5-20

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mg/kg) (Charanjeet *et al.*, 2004) and also excellent source of minerals and vitamins. Tomato is consumed throughout the year with different forms. It is very appetizing, refreshing and has a pleasing taste.

The excess production of tomato results in a glut in the market and reduction in tomato prices. However, marketing of fresh tomato during the season is a great problem because of its shorter postharvest shelf life, resulting in high postharvest losses of 35-38% (BBS, 2011). Shorter shelf life as well as lack of appropriate processing and preservation techniques also results in loss in national economy of Bangladesh. To increase the shelf life of tomatoes, nowadays different preservation techniques are being employed that comprise of manipulation of storage temperature and relative humidity, addition of chemical preservatives, protection against air/germ pollution through waxing, dehydration and processing into other products. But due to lack of effective preservation techniques farmers cannot preserve fresh tomatoes for longer periods.

Different products such as puree, sauce, ketchup, pickles etc. are prepared from fresh tomato, but these products have shorter shelf life due to their high moisture content. These products also create problems during transportation and storage because of their bulk volume compared to dehydrated product. The reason of preparing dehydrated tomato powder also concerns the ease of transportation handling and storage without extra care. If powder can be prepared then it will help to reduce wastage, price and increase the availability of powdered tomato throughout the year (Jayathunge *et al.*, 2012). The dehydrated tomato powder can also be used as substitute of raw tomato to develop new food recipe. Whereas, high cost technology is required for developing good quality products from fresh tomato. Therefore development of low cost processing and packaging methodologies to produce shelf-stable and convenience products are the prime requirements of present competitive market. In this perspective, drying is the best technique because it reduces the volume and minimizes the transportation cost so that consumer will get quality product at a minimum and affordable price. And, farmer will be benefited to maximize their yield and production. Therefore drying is the most suitable and comparatively low cost method to fulfill the above requirements (Mozumder *et al.*, 2012).

Based on the information as accumulated above the research was conducted to find out the suitable packaging material for tomato powder based on compositional changes and viable load in the powder during storage of six months.

Materials and methods

Collection and Pretreatment of Samples

The fresh, ripe and matured tomatoes (Proseed variety) having diameter 60-75 mm and weight 90-110 g were collected from the local market at Bansher Hat, Dinajpur and the defected ones were sorted out. The tomatoes that possessed greenish red were considered as the best ones for this study. Then the tomatoes were washed with distilled water and cut into slices by 5 mm of thickness and dipped in salt solution (1% $CaCl_2$ and 0.2% KMS) for 10 minutes at room temperature.

Preparation and Packaging of tomato powder

Tomato powder was prepared by following the method as described by Rao *et al*. (2011) and Mozumder *et al*. (2012). The treated tomato slices were dried in the cabinet drier at 60 ^{0}C temperatures for 26 hours and the dried tomato flakes were ground in order to produce tomato powder. Finally, the tomato powder was packed into different packaging materials like High Density Polyethylene (HDPE), Medium Density Polyethylene (MDPE), and Laminated Aluminum Foil (LAF) pouches for six months.

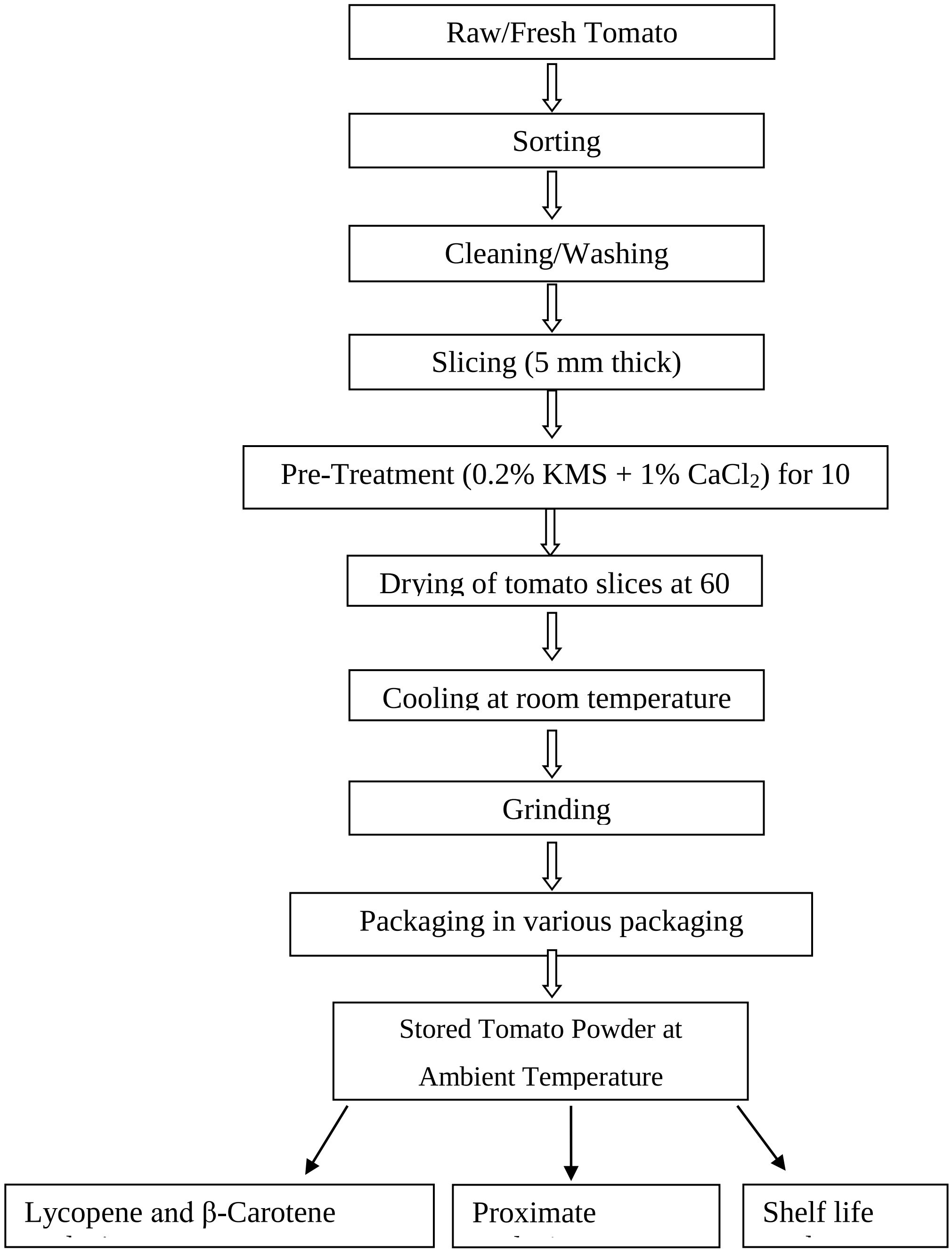

Fig. 1. Flowchart for production and analysis of tomato powder

Chemical analysis

The tomato powder was analyzed to determine the moisture, crude protein, crude fat, total ash, pH, acidity using the official methods mentioned in the Association of Official Analytical Chemist (AOAC, 1990). Vitamin C of tomato powder was determined using the method developed by Rangana (1992). And the lycopene and β-Carotene contents were determined by HPLC as recommended by Charanjeet *et al*., 2004.

Microbiological analysis

Total viable load interms of bacteria and fungi in the tomato powder was evaluated by standard procedure of series dilution through the pour plate methods (Adegoke, 2004).

Physical analysis (Rehydration ratio)

Rehydration ratio of the tomato powder was calculated following the methods as recommended by Jokic *et al*. (2009).

Shelf-life study of tomato powder

Chemical, microbial and physical analyses of the tomato powder packed in different packaging material were conducted at an interval of two months during the storage period of six months.

Results and discussion

Yield of tomato powder

The recovery of the tomato powder was 4.65% in this study, which was lower than that of the values (5.75%) as found by Rao *et al*. (2011).

Drying characteristics

A rapid rate of water removal from tomato slices was observed for first 12 hours and after 13 hours the falling rate was observed without any constant rate period. After 26 hours it reached to the equilibrium moisture content of 8.42% as shown in Figure 2, which was similar to the results as reported by Jayathunge *et al*. (2012) and Mozumder *et al*. (2012).

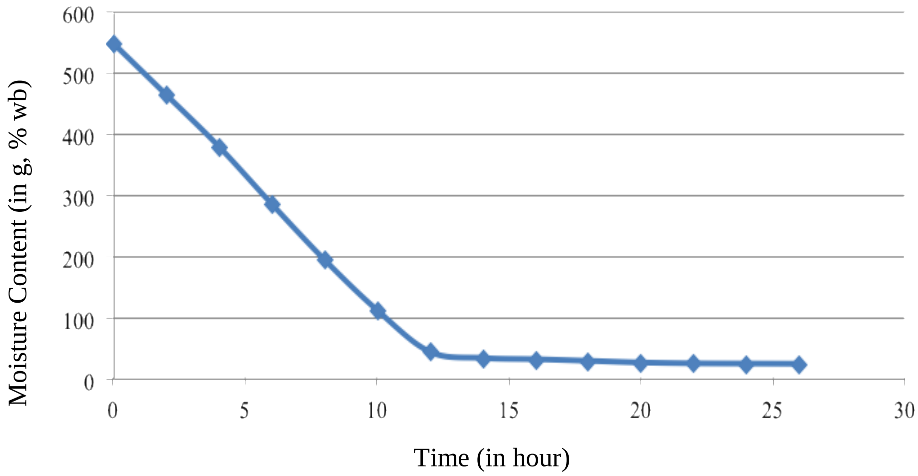

Fig. 2. Drying Curve for Tomatoes treated with 0.2% KMS + 1% $CaCl_2$ Chemical composition of tomato powder

Compositions of freshly prepared tomato powder are presented in Table 1. In the study, moisture (8.12%), protein (14.3%), fat (2.1%), ash (9.22%), pH (4.3), acidity (6%), Vitamin C (35.1 mg/100g), lycopene (18.34 mg/100g) and β-Carotene (4567 µg/100g) was found in prepared tomato powder. These results were slightly higher or lower than results recorded by Mozumder *et al*. (2012) who observed moisture (5.9%), protein (13.9%), fat (3%), ash (10.72%), pH (4.25), and acidity (6.05%) in tomato powder.

Table 1. Chemical composition of tomato powder

Parameters	**Quantity**
Moisture (%)	8.12
Protein (%)	14.3
Fat (%)	2.1
Ash (%)	9.22
pH	4.3
Acidity (%)	6
Vitamin C (mg/100g)	35.1
Lycopene (mg/100g)	18.34
β-Carotene (µg/100g)	4567

Shelf life of the tomato powder

Changes in various parameters namely moisture, protein, fat, ash, pH, acidity, and rehydration ratio of tomato powder during storage are presented in Table 2. The moisture content of tomato powder in LAF, HDPE and MDPE pouches were not changed significantly during the storage period. Maximum moisture content (9.45%) was found in MDPE pouches, where the lowest value was 8.15% in LAF which were significantly lower than that of those values as reported by and Rao *et al*. (2011) who found 18.03% and 17.13% moisture in polyethylene (PE) and metalized polyethylene (MPE) respectively after six months of storage.

During the storage period, it was observed that rehydration ratio of tomato powder decreased with the increase of moisture content, and the decreasing rate was higher in HDPE and MDPE pouches than that in LAF pouches. The highest rehydration ratio of the tomato powder was found 6.4 in LAF pouches, which might be according to observation of Jay (2000) who reported the rehydration ratio is usually decreased as increase in moisture content.

Table 2. Moisture, protein, fat, ash, pH, acidity and rehydration ratio of tomato powder in three packaging materials during storage

Parameter	**Storage period (months)**								
		LAF			HDPE			MDPE		
	0	2	4	6	2	4	6	2	4	6
Moisture (%)	8.12	8.12	8.19	8.25	8.21	8.70	9.12	8.25	9.0	9.45
Protein (%)	14.3	14.3	13.4	10.3	13.6	11.19	8.69	12.6	9.36	8.54
Fat (%)	2.1	2.1	2.0	1.86	2.0	1.80	1.63	1.99	1.79	1.58
Ash (%)	9.22	9.22	9.32	9.45	9.25	9.37	9.52	9.27	9.38	9.55
pH	4.30	4.30	4.21	3.77	4.23	4.14	3.64	4.23	4.12	3.58
Acidity (%)	6.0	6.05	6.5	8.0	6.1	6.58	8.5	6.1	6.60	8.53
Rehydration ratio	6.45	6.45	6.43	6.4	5.35	5.1	4.5	5.35	5.0	4.3

In this study, it was found that pH of tomato powder decreased, and acidity content of powder increased with the increase of storage time. The decreasing rate of pH for tomato powder stored in HDPE and MDPE pouches was similar, but higher than the rate for powder stored in LAF pouches. pH of tomato powder in LAF pouches decreased from 4.3 to 3.77 following the increase of acidity from 6.0 to 8.0 after storage of six months. The pH value 3.77 is most suitable for different processing of tomato products because pH < 4.5 often lowers the proliferation of microorganisms in the final product during industrial processing (Giordano *et al*., 2000).

Protein content of tomato powder decreased more in both HDPE and MDPE. Protein content decreased from 14.3 to 8.69 and 8.54% in HDPE and MDPE pouches respectively during storage of six months. Conversely, protein content decreased from 14.3 to 10.3% in LAF pouches, which was maximum protein content during storage period. This degradation rate was slow for its high moisture, oxygen (O_2) and gas barrier properties which was reliable with the finding of the study carried out by Guyana (2010).

The degradation rate of fat in tomato powder was high in both HDPE and MDPE pouches than LAF pouches. Fat content decreased from 2.1 to 1.63 and 1.58% in HDPE and MDPE pouches respectively whereas, the value was 1.86% in LAF pouches after six months of storage.

Ash content of tomato powder increased in all packaging materials with the increase of storage period. When the degradation rates of other components of tomato powder were higher in a packaging material, the increasing rate of ash content was low. Higher ash content (9.55%) was found in MDPE pouches and lowest one (9.45%) was in LAF pouches after six months.

Changes in micronutrient namely ascorbic acid, lycopene and β-carotene content during storage are presented in Table 3. Table 3 shows that ascorbic acid content of tomato powder was dramatically decreased from 35.1 to 3.05 mg/100g and 1.96 mg/100g in both of HDPE and MDPE pouches by storage. The degradation rate of ascorbic acid content was high in both HDPE and MDPE pouches because of poor oxygen barrier property. But the degradation rate was slightly lower in LAF pouches and the highest value (11.51 mg/100g) was found in LAF pouches after storage.

Lycopene content of tomato powder was decreased significantly in both HDPE and MDPE, which was decreased from 18.34 to 1.45 and 1.13 mg/100g respectively. Conversely, a significant loss in lycopene content was observed in LAF pouches. Lycopene content of the powder (2.29 mg/100g) in LAF pouches was lower than the value as found by Rao *et al*. (2011), who mentioned the lycopene content 2.39 mg/100g in the tomato powder packed in polyethylene pouch after storage period of six months.

Table 3. Ascorbic acid, lycopene and β-carotene content of tomato powder in three packaging materials during storage

Packaging materials	Storage period (months)	Ascorbic acid	Lycopene	β-Carotene
LAF	0	35.1	18.34	4.57
	2	25.1	12.57	3.39
	4	19.76	8.85	3.29
	6	11.51	2.29	1.71
HDPE	0	35.1	18.34	4.57
	2	17.3	10.76	3.65
	4	12.39	5.79	2.72
	6	3.05	1.45	1.29
MDPE	0	35.1	18.34	4.57
	2	14.45	9.89	3.3
	4	8.23	4.01	2.17
	6	1.96	1.13	1.06

The degradation rate of β-carotene of tomato powder in both HDPE and MDPE pouches were higher than the rate in LAF pouches. After a period of six months, the highest value of β-carotene was found 1.71 mg/100g in LAF and the lowest one was 1.06 mg/100g in MDPE pouches. It was found that β-carotene contents in both HDPE and MDPE pouches were low because of their poor gas and oxygen barrier property as well as proper controlling of temperature and storage environment or humidity (Dutta B. *et al*., 2007). They also reported that β-carotene content of dried sample depends on temperature, storage period and storage condition.

Microbial study of tomato powder

Viable load of the tomato powder during storage of six months are shown in Table 4. The results show the viable load of tomato powder packed in both HDPE and MDPE pouches were higher than the range accepted by International Commission on Microbiological Specification for foods (2002), where value $<10^5$ for bacteria and 10^3-10^4 for fungi after storage period. On the other hand, microbial load of tomato powder packed in LAF pouches was only under the acceptable label, where the bacterial and fungal load was 3.12×10^2 and 7.87×10^2 respectively after six months storage.

Table 4. Viable load of tomato powder in three packaging materials during storage

Packaging materials	Storage period (months)	Viable load (cfu/g)	
		Bacteria	Fungi
LAF	2	1.78×10^2	3.76×10^2
	4	2.25×10^2	4.59×10^2
	6	3.12×10^2	7.87×10^2
HDPE	2	2.26×10^2	4.1×10^2
	4	2.98×10^2	7.56×10^3
	6	3.97×10^2	1.14×10^4
MDPE	2	2.58×10^2	4.5×10^2
	4	3.16×10^2	8.13×10^3
	6	4.12×10^2	1.47×10^4

Conclusion

To ensure the maximum hygienic quality and nutritional value like protein, fat, crude fiber, ascorbic acid, lycopene and β-carotene, tomato powder might be stored for maximum six months in laminated aluminum foil (LAF) at room temperature by applying pre-treatment with a salt solution of 1% $CaCl_2$ + 0.2% KMS prior to drying at 60 ^{0}C.

References

AOAC (1990). Official Methods of Analysis 12th Ed. Association of Official Analytical Chemist, Washington D.C.

Adegoke, G.O. (2004). Understanding Food Microbiology 2nd edition, pp. 173-176.

BBS. (2011). Yearbook of Agricultural Statistics of Bangladesh. Planning Division, Ministry of Planning, Peoples Republic of Bangladesh, Dhaka.

Cernisev, S. and Sleagun, G. (2007). Influence of dehydration technologies on dried tomato biological quality and value. Cercetari Agronomice in Moldova 40(3):63-68.

Charanjeet, K., George, B., Deepa, N., Singh, B. and Kapoor, H.C. (2004). Antioxidant status of fresh and processed tomato. J. Food Sci. and Technology, 41(5): 479-486.

Dutta, D., Chaudhuri, U.R. and Chakraborty, R. (2005). Structure, health benefits, antioxidantproperty and processing and storage of carotenoids. African Journal of Biotechnology, 4(13):1510-1520.

Ghavidel, R.A. and Davoodi, M.G. 2009. Effect of chemical pretreatment and dehydration method on quality characteristic of tomato powder and its store stability, pp 1434- 1443.

Giordano, L.B., Silva, J.B.C. and Barbosa, V. (2000). Escolha de cultivars eplantio. In: Silva JBC and Guarding LB (org) Tomatoe para processamento industrial. Brasilia: Emrapa, CNPH, pp. 36-59.

Giovanelli, G., Lavelli, V., Peri, C., Pagliarini, E., Zanoni, B. and Spigno, P. (2001). The antioxidant activity of tomato. III. Effects of processing technologies on oxidative and heat damage, pp. 217-220.

Guyana (2010). Plastic packaging films and laminates; properties, specifications &purchasing. Workshop: procurement of packaging of export Guyana, April. pp. 19-23.

ICMSF (2002). Microorganisms in Foods 7. Microbiological testing in food safety management. Kluwer Academic / Plenum Publishers, New York, USA.

Jay, J.M. (2000). Preservation of foods by drying, Modern Food Microbiology (6th Edition). An Aspen Publication, Aspen Publishers, Inc., Gaithersburg, Maryland, pp 363-374.

Jobber, P.I. and Jamieson, M.F.S. (1969). Food microbiology: Food storage manual. Part I. World Food Program. FAO. pp. 65-135.

Jokic, S., Velic, D., Bilic, M., Lukinac, J., Planinic, M. and Bucic-Kojic, A. (2009). Influence of process parameters and pre-treatments on quality and drying kinetics of apple samples. Czech Journal of Food Sciences, 27:88-94.

Krokida, M.K. and Zacharias, B.M. and George, D.S. (2001). The effect of the method of drying on the colour of dehydrated products. International Journal of Food Science and Technology 36:53-59.

Lewicki, P.P., Le, H.V. and Lazuka, W.P. (2002). "Effect of pretreatment on convective drying of tomatoes', Journal. Food Eng., 54:141-146.

Mozumder, N.H.M.R., Rahman, M.A., Kamal, M.S., Mustafa, A.K.M and Rahman, M.S. (2012). Effects of pre-drying chemical treatments on quality of cabinet dried tomato powder, pp. 253-264.

Nahar, K., Ullah, S.M. and Gretzmacher, R. (2011). Influence of soil moisture stress on height, dry matter and yield of seven tomato cultivars. Canadian Journal of Scientific and Industrial Research., 2: pp. 4.

Nguyen, M.L. and Schwartz, S.J. (1999). Lycopene stability during food processing. Nigerian Food Journal 22:195-202.

Ranganna, S. (1992). Hand Book of Analysis and Quality Control of Fruit and Vegetable products. Tata McGraw Hill Publishing Co. Ltd., New Delhi. pp. 931-932.

Rao, G.N., Rao, P.G.P., Balaswamy, K. and Rao, D.G. (2011). Preparation of instant tomato pickle mix and evaluation of its storage stability. International Food Research Journal 18:589-593.

Toyin, A.D. (2010). Effect of variety and pre-treatment condition on the shelf stability of dried tomato slices. Project paper: pp. 45-68.

Velic, D., Planinic, S., Tomas, S. and Bilic, M. (2004). Influence of air flow velocity on kinetics of convection apple drying. Journal of Food Engineering 64:97-102.

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