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Heat utilization in different methods of turmeric boiling

K.A. ATHMASELVI AND N. VARADHARAJU
Department of Agricultural Processing, Tamil Nadu Agrl. University, Coimbatore-641 003, Tamil Nad

Abstract: The turmeric rhizomes were boiled in open steam and also under different pressure and duration. The heat utilization factor for different methods of boiling was determined and compared. The rhizomes boiled in open steam for 15 min showed the highest heat utilization factor and the rhizomes boiled at 0.5 kg/cm² for 5 min showed the highest per cent of curcumin, oleoresin and essential oil content.

Key words : Rhizomes, Curcumin, Oleoresin.

Introduction

Turmeric is one of the important spice and cash crops of India and a traditional item of export. It forms an important adjuvant in Indian culinary as it lends colour and aromatic flavour to various dishes. Nothing could be more auspicious to Indians than turmeric (Pujari *et al.* 1986). The conventional method of boiling, using either cowdung slurry or soda not only results in high contamination in the final product but also requires more energy to get cooked and more time to dry the product.

Improper cooking of turmeric rhizomes by the conventional method makes the product brittle and results in easy attack of *Leusioderma serricorne* which leads to 40 per cent of the turmeric losses (Abdulla Koya *et al.* 1992). A thought was given for the novel method of pressure boiling of turmeric. The principle of this method is the penetration of moisture into the rhizome in the form of water vapour under pressure which gelatinizes the starch in the rhizome and makes the rhizome hard.

Hence a study was under taken at the Dept. of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore to process the turmeric under pressure boiling in order to reduce energy consumption and to get more uniformly boiled product with enhanced quality. The quality factors like curcumin, oleoresin, essential oil and microbial studies were conducted on individual methods of boiling.

Materials and Methods

Energy requirement in the conventional method of boiling

A rectangular container made of mild steel was used for boiling. One hundred kg of turmeric was loaded in the container an 30 litres of water was poured along with 2(gram of sodium bicarbonate. The container wa covered with a gunny bag which was dippe in cowdung slurry. The cooking last for abou 50 min to 1 h, completion of cooking wa judged by the fumes and the fragrance of th turmeric and also by piercing a stick throug the turmeric. After completion of boiling th container was lifted from the stove using tw bamboo poles.

The initial and final temperatures of the rhizomes were recorded. The final weight of the rhizomes after boiling was noted and the amount of fuel used for boiling was also calculated.

Heat absorbed by the rhizomes during boiling in conventional method was calculated using the following equation.

$$Q_b = W_{dm} C_{pt} (T_f - T_i) + W_{mt} C_{pw} (T_f - T_i) \quad \ldots. 1$$

Heat utilization factor for conventioal method of boiling :

$$H.U.F = \frac{\text{Energy utilized}}{\text{Energy supplied}}$$

$$= \frac{Q_b}{W_f \times C_v} \quad \ldots. 2$$

Energy requirement in open steam boiling

The energy required to boil 2 kg of rhizomes was determined using a laboratory

odel paddy parboiling drum lanian and Kathirvel, 1984). our litres of water was heated the drum using electric heater d an energy meter was used measure the energy consumed y the heater. The unit was lowed to run in the no load ndition till steam comes out d the time was noted. The izomes were kept in the drum, vered with the lid and boiled r 15, 25 and 35 min. The itial and final temperature of e rhizome after boiling and e weight of the turmeric after oiling were recorded.

The heat utilized by the izomes during boiling in open eam method was calculated sing the following equation.

$$Q_{bo} = W_{dm} C_{pt} (T_f - T_i) + W_{mt} C_{pw} (T_f - T_i) \quad .... 3$$

Q_{bo} = Heat utilized during boiling n open steam, kJ

$$H.U.F = \frac{\text{Energy utilized}}{\text{Energy supplied}}$$

$$= \frac{Q_{bo}}{W_R \times CF \times t} \quad .... 4$$

Energy requirement for pressure boiling

To study the pressure boiling of tumeric, an autoclave was used. The autoclave was filled with 6 litres of water and heated using electric heater and an energy meter was used to measure the energy consumed by the heater. Turmeric (2 kg) was kept inside the autoclave and covered with the lid. Time

Table 1. Heat utilization of the boiling unit

Treatment	Initial weight of rhizomes (g)	Final weight of rhizomes (g)	Moisture lost (g)	Inital Temp. of rhizomes °C	Final Temp. of rhizomes °C	Heat utilized, kJ/kg	Heat supplied kJ/kg	HUF
Conventional	1000	1015	-	32.0	98.0	333.30	7458	0.05
In open steam 15 min	1000	1000	0	29.0	94.0	287.45	900	0.32
In open steam 25 min	1000	1000	0	29.5	94.5	287.45	1500	0.19
In open steam 35 min	1000	1000	0	29.0	95.0	291.87	2100	0.14
In open steam with soda 15 min	1000	1000	0	29.0	94.0	287.46	900	0.32
In open steam with soda 25 min	1000	1000	0	29.5	94.5	287.46	1500	0.19
In open steam with soda 35 min	1000	1000	0	29.5	95.5	291.87	2100	0.14
In pressure 50 kPa, 5 min	1000	998	2	30.0	84.0	243.37	1200	0.20
In pressure 50 kPa, 10 min	1000	998	2	30.0	84.5	245.58	1800	0.14
In pressure 50 kPa, 15 min	1000	998	2	30.5	85.0	245.58	2400	0.10
In pressure 75 kPa, 5 min	1000	998	2	30.0	101.0	318.43	1200	0.27
In pressure 75 kPa, 10 min	1000	998	2	30.0	101.5	320.62	1800	0.18
In pressure 75 kPa, 15 min	1000	996	4	30.5	101.5	322.84	2400	0.13
In pressure 100 kPa, 5 min	1000	998	2	31.0	104.0	327.24	1200	0.27
In pressure 100 kPa, 10 min	1000	996	4	30.0	104.0	332.96	1800	0.19
In pressure 100 kPa, 15 min	1000	996	4	30.5	104.5	332.96	2400	0.14

Table 2. Effect of boiling on the curcumin content, oleoresin and essential oil of turmeric

Treatments	Curcumin (%)			Oleoresin (%)			Essential oil (%)		
	BSR I	BSR II	Erode	BSR I	BSR II	Erode	BSR I	BSR II	Erode
Turmeric + cow dung	4.03	2.91	3.08	3.08	5.84	5.60	3.54	1.58	4.45
Turmeric + soda	3.82	2.80	2.99	2.91	5.43	5.401	3.50	1.46	4.20
Turmeric + water	4.05	2.92	3.17	3.00	5.82	5.62	3.58	1.59	4.42
In open steam 15 min	4.09	2.30	3.20	3.34	5.81	5.73	3.90	1.62	4.52
In open steam 25 min	4.09	2.30	3.20	3.32	5.83	5.73	3.90	1.62	4.56
In open steam 35 min	4.08	2.30	3.20	3.33	5.84	5.73	3.90	1.63	4.56
In open steam with soda 15 min	3.91	2.80	2.99	2.98	5.44	5.41	3.50	1.52	4.25
In open steam with soda 25 min	3.92	2.80	2.99	2.99	5.45	5.41	3.45	1.51	4.25
In open steam with soda 35 min	3.91	2.80	2.99	2.99	5.46	5.41	3.45	1.50	4.26
In pressure 50 kPa, 5 min	4.11	2.80	3.21	3.35	5.84	5.73	3.93	1.63	4.56
In pressure 50 kPa, 10 min	4.11	2.80	3.21	3.35	5.84	5.73	3.93	1.65	4.56
In pressure 50 kPa, 15 min	4.10	2.80	3.20	3.36	5.84	5.73	3.94	1.65	4.56
In pressure 75 kPa, 5 min	4.08	2.80	3.20	3.35	5.84	5.73	3.75	1.65	4.54
In pressure 75 kPa, 10 min	4.08	2.80	3.20	3.35	5.83	5.73	3.80	1.65	4.54
In pressure 75 kPa, 15 min	4.07	2.80	3.10	3.34	5.80	5.73	3.80	1.65	4.54
In pressure 100 kPa, 5 min	4.05	2.80	3.20	3.34	5.83	5.73	3.80	1.64	4.51
In pressure 100 kPa, 10 min	4.05	2.80	3.20	3.34	5.83	5.73	3.70	1.64	4.53
In pressure 100 kPa, 15 min	4.05	2.80	3.20	3.34	5.83	5.73	3.60	1.64	4.50

taken to reach the requir pressure (100,75,50, kPa) wa noted, and the rhizomes wer boiled at these pressures fo 5,10 and 15 minutes duratio The initial and fin temperatures of the rhizom and the weight of the turmeri after boiling were noted.

Heat energy utilized b the turmeric during boiling wa measured by the following hea balance equation.

Heat utilized =

Heat absorbed by dry matte + Heat absorbed by moistur in the turmeric + Heat utili zed to evaporate moisture fro turmeric

$$Q_{bp} = W_{dm} C_{pt} (T_f - T_i) + W_{mt} C_{pw} (T_f - T_i) + W_e l \quad ....$$

$$H.U.F = \frac{\text{Energy utilized}}{\text{Energy supplied}}$$

$$= \frac{Q_{bp}}{W_R \times CF \times t}$$

Drying of turmeric rhizomes

The boiled rhizomes were dried in cross flow drier at 60°C (Sampathu *et al.* 1988). The drying conditions were kept constant for all the experiments and was carried out till the moisture content of the samples reached 8-10 per cent (w.b.).

Quality assessment of cured turmeric

The quality of the turmeric boiled by conventional, open steaming and pressure boiling method was analysed for the curcumin (Jacob and

irghese, 1981), Oleoresin (ASTA, 1975) and sential oil (ASTA, 1968).

esults and Discussion

The pattern of amount of heat utilized i boiling of turmeric using conventional, open eam and pressure boiling is presented in Table 1.

nergy required for boiling in conventional method

The amount of heat utilized to boil 100 g of turmeric was 333.3 kJ and the heat tilization factor was 0.046. The low H.U.F. i this method may be due to boiling of rhizomes i open area which increases the loss of heat rough radiation.

nergy required for boiling in open steam method

The energy utilized for boiling increased ith increase in the duration of boiling and nged between 287.45 kJ to 291.87 kJ. The crease in heat utilization is due to more contact me which facilitated the rhizomes to absorb ore amount of heat from the steam. The eat utilization factor decreased when the duration f boiling increased.

nergy required for pressure boiling

Heat utilization in pressure boiling for he various pressrue and duration ranged between 43.37 kJ to 332.96 kJ. As the pressure and the duration of the boiling increased the heat utilization also increased. It may be due to more contact time which facilitated the rhizomes to absorb more amount of heat from the steam and also due to heat utilized to evaporate small amount of moisture from the rhizome. The heat utilization factor ranged between 0.102 to 0.272 for the various pressures (50,75 and 100 kPa) and duration (5,10 and 15 min). As in the open steam process the heat utilization factor reduced when the duration of boiling was increased.

The effect of boiling on curcumin, oleoresin and essential oil contents is presented in the Table 2.

The curcumin, oleoresin and essential oil content was maximum when the rhizomes was boiled at 50 kPa pressure for a duration of 5 to 15 min. for all the varieties tested. The lower amount of curcumin, oleoresin and essential oil in the conventional process may be due to the fact that during the boiling process some amount of curcumin, oleoresin and essential oil might have leached along with the boiled water. In the pressure boiling process the curcumin, oleoresin and essential oil content decreased as the pressure was increased. Elevation of the steam temperature to higher levels (75 kPa and 100 kPa) might have influenced the evaporation of the curcumin, oleoresin and essential oil. There was no change in curcumin, oleoresin and essential oil content in open steam boiling, since the temperature of the rhizomes was not increased above 94°C.

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