Influence of Curing Parameters on Quality and Yield of Turmeric (Curcuma longa)

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ABSTRACT
The study was conducted to investigate the effect of curing parameters i.e. steam pressure and holding time on recovery and quality of turmeric powder obtained from raw turmeric rhizomes. The turmeric rhizomes were cured at different hydro thermal treatments using an autoclave. The effect of steam pressure and holding time was studied by varying the steam pressure from 10 psi to 20 psi and holding time from 0 minutes to 15 minutes. Each batch of rhizomes was cured by varying the curing conditions and another batch was kept as control sample. The rhizomes were dried by solar assisted dryer at a temperature of 60ºC. The boiled rhizomes were analyzed for moisture content and drying time. The final recovery of pulverized powder ranged from 17.93% to 21.32%. It was observed that heat treatment by steam application reduced the drying time and steam cured turmeric was much superior to the control (unboiled) sample in every respect of quality, recovery and color characteristics.

Keywords: Turmeric, Curing, Steam, Drying, Curcumin.

INTRODUCTION
Turmeric (Curcuma longa) plant belongs to Zingiberaceae family and is grown for its underground growing stem bearing shoots and roots. It is also referred to as haldi, gelbwurzsel, safran des Indes, dilau and yellow or golden ginger. Rhizomes of turmeric when dried and grinded produce a yellow luscious powder. Turmeric powder is one of the most indispensable constituents of curry, used in religious celebrations, as cloth dying compound and in many customary health remedies and is famous as the ‘Golden Spice of Life’. Turmeric has been respected globally as a functional food. It has been used as an antioxidant, digestive, anti-inflammatory and anti-carcinogenic agent. Turmeric contains 6% curcuminoid pigments and 5% of essential oils (Nunes, 1989).

Turmeric is admired for its deep yellow color and fragrant flavor. The core of turmeric is red colored which after boiling turns into uniform yellow color. Post harvest processing practices like washing, boiling, drying, polishing and grinding are followed to convert turmeric rhizomes into stable final turmeric powder.

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After cleaning and washing is completed, turmeric rhizomes have to be boiled or cured.

Boiling or curing is the first post harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water until they become soft and are ready for drying. During boiling, the starch gets gelatinized which reduces the required drying time significantly and the color is homogeneously dispersed throughout the rhizomes. The starch gelatinization not only facilitates rapid drying but also provides shield against insect infestation throughout the storage (Gounder & Lingamallu, 2012). Boiling process also exterminates the vigor of fresh rhizomes along with the eliminating the raw turmeric odor. After the rhizomes are harvested from field, boiling should be finished within 10 days to achieve maximum final product. However conventional boiling in open vessels result in a product of poor quality so steam boiling or blanching of the rhizomes is more preferred as it leads to a product of higher quality and minimum losses. Therefore it is important to investigate the effect of boiling parameters i.e steam pressure and steam holding time on the quality of ground turmeric. The study was conducted to understand the effect of both the parameters on the product and be able to find the best curing parameters for turmeric rhizomes. The specific objectives were to investigate the effect of boiling parameters on the yield, curcumin content and the color characteristics of the polished rhizomes.

MATERIALS AND METHODS

2.1 Processing of turmeric

Raw mature rhizomes of turmeric (Curcuma longa) were procured from a local farmer. The procured raw rhizomes were cleaned and washed in running water to remove any sticking mud and residue. The cleaned and thoroughly washed rhizomes were graded by hand. The finger rhizomes were separated from the mother rhizomes.

Boiling or curing is the most important and complicated operation in the processing of turmeric and it was completed in an autoclave. The autoclave employs steam for curing the rhizomes which results in less wet rhizomes. The boiling/curing parameters i.e steam pressure and holding time were varied for different combinations. Each batch of rhizomes (5 kg) was loaded into the autoclave and the steam pressure increased to a desired value. Once the required pressure was reached it was retained for a particular holding time. The steam pressure was varied as 10-15-20 psi and the holding time as 0-5-10-15 minutes. The different combinations of steam pressure and holding time were abbreviated as P_{10T_0}, P_{10T_5}, P_{10T_10}, P_{10T_15}, P_{15T_0}, P_{15T_5}, P_{15T_10}, P_{15T_15}, P_{20T_0}, P_{20T_5}, P_{20T_10}, P_{20T_15} and control sample. The boiled samples were then dried in a solar dryer provided with auxiliary heating mechanism. During the sunshine hours heat from the solar tubes was sufficient to provide with required drying effect and the auxiliary heater helped during overcast weather conditions and during night. The dried rhizomes were then polished using a polishing machine and the polished rhizomes were ground into powder using a hammer mill. The polished rhizomes and powder obtained were then analyzed for curcumin content.

Fig. 1: Dried rhizomes, unpolished and polished rhizome and feeding of polished rhizomes in the grinding machine
Moisture content of the boiled rhizomes was determined using the oven drying method. The samples dried to bone mass in the oven and were then kept in the desiccators. The total time taken for drying the rhizomes from initial moisture content to the final moisture content condition of bone dryness was noted down.

Color of the turmeric rhizomes is vital as it controls the marketable value and recognition of the product in the market. Color was measured using the Hunter Lab Miniscan XE Plus Colorimeter. The final recovery of the turmeric obtained after processing represented the ground turmeric powder obtained in comparison to the initial weight of raw turmeric processed. The curcumin content of pulverized turmeric powder was estimated by method of Bagchi 2012.

### Table 1: Effect of different combinations of steam pressure on quality and recovery of turmeric

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture Content (wb%)</th>
<th>Drying Time (Hours)</th>
<th>Color Characteristics of Polished Rhizomes</th>
<th>Final Recovery (%)</th>
<th>Curcumin Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L  a  b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{10}-T_0</td>
<td>81.02±0.46</td>
<td>64.3±1.15</td>
<td>44.10±1.32  6.33±0.38  40.97±2.18</td>
<td>20.44±1.20</td>
<td>3.84±0.28</td>
</tr>
<tr>
<td>P_{10}-T_5</td>
<td>80.36±2.04</td>
<td>62.7±5.13</td>
<td>43.97±1.33  5.47±0.21  39.80±1.08</td>
<td>20.83±0.73</td>
<td>2.81±0.23</td>
</tr>
<tr>
<td>P_{10}-T_{10}</td>
<td>78.24±2.32</td>
<td>57.3±8.86</td>
<td>41.17±4.10  5.67±0.12  38.90±1.15</td>
<td>19.26±1.00</td>
<td>2.64±0.12</td>
</tr>
<tr>
<td>P_{10}-T_{15}</td>
<td>77.19±2.64</td>
<td>54.7±6.66</td>
<td>40.47±1.36  4.93±0.15  36.20±0.82</td>
<td>18.78±1.54</td>
<td>2.37±0.13</td>
</tr>
<tr>
<td>P_{15}-T_0</td>
<td>80.23±3.03</td>
<td>62.3±7.64</td>
<td>43.83±0.42  6.77±0.12  41.43±1.93</td>
<td>20.62±1.13</td>
<td>4.13±0.47</td>
</tr>
<tr>
<td>P_{15}-T_5</td>
<td>77.32±2.60</td>
<td>55.0±6.56</td>
<td>44.23±0.65  6.57±0.21  40.30±2.10</td>
<td>21.32±0.59</td>
<td>4.03±0.19</td>
</tr>
<tr>
<td>P_{15}-T_{10}</td>
<td>77.05±5.28</td>
<td>54.3±13.32</td>
<td>39.90±1.21  5.87±0.31  38.53±1.21</td>
<td>19.80±1.55</td>
<td>3.55±0.22</td>
</tr>
<tr>
<td>P_{15}-T_{15}</td>
<td>76.92±3.10</td>
<td>54.0±7.81</td>
<td>39.97±0.61  4.70±0.36  35.53±3.25</td>
<td>18.16±10.99</td>
<td>2.47±0.24</td>
</tr>
<tr>
<td>P_{20}-T_0</td>
<td>80.10±3.00</td>
<td>62.0±7.55</td>
<td>41.50±2.62  5.07±0.38  34.80±1.04</td>
<td>20.42±0.41</td>
<td>3.22±0.23</td>
</tr>
<tr>
<td>P_{20}-T_5</td>
<td>77.32±0.40</td>
<td>55.0±1.00</td>
<td>39.87±0.65  4.90±0.20  34.93±2.08</td>
<td>20.19±0.57</td>
<td>2.86±0.14</td>
</tr>
<tr>
<td>P_{20}-T_{10}</td>
<td>76.79±4.63</td>
<td>53.7±11.68</td>
<td>38.90±1.14  4.73±1.01  31.43±2.78</td>
<td>19.05±1.22</td>
<td>2.57±0.16</td>
</tr>
<tr>
<td>P_{20}-T_{15}</td>
<td>76.66±5.56</td>
<td>53.3±14.01</td>
<td>38.20±1.01  4.10±0.36  30.37±1.61</td>
<td>17.93±1.48</td>
<td>2.18±0.16</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td>44.12±0.93  4.97±0.40  31.60±2.15</td>
<td>19.14±1.64</td>
<td>2.81±0.26</td>
</tr>
<tr>
<td><strong>C.D (0.05%)</strong></td>
<td></td>
<td>11.34</td>
<td>2.29  0.55  2.69</td>
<td>1.61</td>
<td>0.35</td>
</tr>
</tbody>
</table>
3.2 Drying time (hours)

Drying time (hours) was influenced significantly by different treatments. Maximum drying time (160 hrs) was taken by the control sample, which was significantly higher than all other treatments. Minimum drying time of 53.33 hours was observed when rhizomes were blanched for 15 minutes hold time at a pressure of 20 psi ($P_{20}T_{15}$); however the difference in drying time among treatments except control was not significant. It was observed that drying time taken by blanched rhizomes was almost similar irrespective of pressure or holding time. This contrasting difference among control and blanched rhizomes can be explained as blanching the rhizome before dehydration promotes gelatinization of starch which in turn facilitates rapid dehydration rate. Consequently, it results in decreased drying time for blanched rhizomes as compared to control (non-blanched) samples (Govindarajan, 1980 & Sampathu et al., 1988).
3.3 Colour (L, a and b) of polished turmeric rhizomes

The color (L, a and b) of polished turmeric rhizomes was significantly influenced by different treatments. The luminosity (L) of turmeric rhizomes varied from 38.20 (P20T15) to 44.23 (P15T3). It was observed that maximum luminosity (44.23) obtained while treating turmeric rhizomes at a pressure of 15 psi for 5 minutes holding time (P15T5) was significantly higher than the control treatment and P20T0, P10T10, P10T15, P15T15, P15T10, P20T5, P20T10, P20T15 while it was at par with P10T0, P10T5 and P15T0. It decreased drastically when steam pressure of 20 psi was applied for any time greater than zero minutes holding time. Thus, it can be concluded that optimum pressure and holding time is crucial for obtaining desirable luminosity (L) values. The luminosity of rhizomes will ultimately affect the color attributes of final ground product.

The intensity of redness (a) was significantly influenced by different treatments. Maximum intensity of redness (a) of 6.77 was recorded with P15T0 treatment which was significantly higher than control treatment (4.97) as well as all other treatments except P15T5 (6.57) and P10T0 (6.33). Lowest intensity of redness (4.10) was observed with P20T15 treatment, which was significantly lower than all other treatments. A sharp decline in intensity of redness with increase in pressure and holding time above certain limit was observed, indicating the importance of optimal pressure and holding time for obtaining desirable intensity of redness.

A significant effect of different treatments on the intensity of yellowness (b) was observed. Highest value of 41.43 was observed with P15T0 treatment, which was significantly higher than control treatment (31.60). Lowest value of 30.37 was recorded with P20T15 treatment which was at par with P20T10 (31.43) and control treatment. The observation that lower value of b (intensity of yellowness) was obtained when rhizomes were untreated (control) or when treated at a high steam pressure (20 psi) and holding time of 10 or 15 minutes made it evident that under cooking or over cooking both failed to obtain the desirable color (b) of turmeric rhizomes.

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Fig. 4: Comparison of effect of different boiling treatments on ‘L’ values of polished turmeric rhizomes
3.4 Final recovery (%)
A significant effect of treatments on final recovery of turmeric powder was observed. Maximum recovery of 21.32 per cent was observed when turmeric was treated for 5 minutes at 15 psi steam pressure ($P_{15}T_{5}$). It was significantly higher than $P_{10}T_{0}$, $P_{10}T_{5}$, $P_{15}T_{15}$, $P_{20}T_{10}$, $P_{20}T_{15}$ and control treatments, but at par with all other treatments. Lowest recovery was observed at $P_{20}T_{15}$ (17.93 per cent), but it was at par with control treatment (19.14 per cent). It can be observed that treatment of turmeric with 15 or 20 psi steam pressure and 15 minutes holding time resulted in decreased final recovery, probably due to increased polishing loss which may be due to increase in brittleness of outer layer as a result of exposure to higher temperature for longer duration.
3.5 Curcumin Content (%)
Different treatments significantly influenced the curcumin content (%) of turmeric powder. Highest curcumin content of 4.13 per cent was observed with P_{15}T_0 treatment, followed with an insignificant difference by P_{15}T_5 and P_{10}T_0 treatments respectively. Lowest curcumin content of 2.18 per cent was recorded in P_{20}T_{15} treatment, which was significantly lower than all other treatments except P_{10}T_{15} treatment. Curcum...
hours was observed when rhizomes were cured for 15 minutes holding time at a steam pressure of 20 psi (P20T15). The maximum luminosity was obtained (44.23) while treating turmeric rhizomes at P15T5 and maximum intensity of redness of polished rhizomes was 6.77 and maximum b value of polished rhizomes 41.43 was observed with P15T0 treatment. Maximum recovery of 21.32 per cent was observed when turmeric was treated for 5 minutes at 15 psi steam pressure and highest curcumin content of 4.13 per cent was observed with P15T0 treatment.

REFERENCES


