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Possible short term storage effect on some chemical properties of locally processed turmeric powder in South-eastern Nigeria

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ABSTRACT

Fresh mother Turmeric rhizomes of NCl 14 variety were randomly harvested and processed into turmeric powders., The turmeric samples were oven dried at different temperatures of 50˚C, 60˚C and 70˚C. The packaging materials used were polyethylene, polypropylene and transparent glass bottles. Samples were stored at room temperature of 27±2.0 while storage period lasted for 6 weeks. Sel ected physico-chemical analyses (moisture, pH and colorimetric absorbance) were determined at 2 weeks interval. The results revealed that drying turmeric at 50˚C, 60˚C and 70˚C and with the mentioned packaging materials maintained their qualities in terms of pH and absorbance. This study recommends 4 weeks storage period for the packaged experimental samples under ambient conditions. Moisture contents were found to significantly increase at 6 weeks storage period under room temperature. Increase in moisture may cause spoilage due to microbes as days of storage extend.

Key words: Turmeric powder, storability, moisture, pH and colorimetric absorbance

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INTRODUCTION

Curcuma Longa Linn (commonly called turmeric) has been used for centuries in medicine and foods. They have also been used as traditional remedies such as antimicrobial and antioxidant agents [1]. Turmeric is native to tropical South Asia but is now widely cultivated in the many tropical and subtropical regions of the world [2]. The deep orange-yellow powder of turmeric is largely prepared from dried rhizomes of the plant and has been used in medicine and food.

Turmeric is an important economic crop cultivated for its underground rhizomes which are widely used in drugs, cosmetic industries, condiments, curry stuffs and in religious and auspicious occasions. It has been traditionally used in indigenous herbal medicines due to its biological activities. Due to its easy digestibility, turmeric has been used in industry to prepare special food and children's foods. Turmeric has long been known in India and many other countries as an important dietary source in addition to their use in traditional medicine for wound healing to cure inflammation and stomach acidity [3][4][5].

In the production of turmeric powder, the rhizomes are ground to approximately 60-80 mesh particle size. Since curcumoids, the colour constituents of turmeric, deteriorate with light and to a lesser extent, under heat and oxidative conditions, it is important that ground turmeric be packed in a UV protective packaging material and appropriately stored [6]. Turmeric powder is a major ingredient in curry powders and pastes. In the food industry, it is mostly used to colour and flavour mustard. It is also used in chicken bouillon and soups, sauces, gravies, and dry seasonings. Recently the powder has also been used as a colorant in cereals [7]. Unlike in India where the rhizomes involve washing, peeling, boiling, blanching before drying and milling into powder, we locally produce the powder in Nigeria without passing through processes like peeling, boiling and bleaching [8].

The phenolic curcuminoid are largely responsible for the yellow –orange colour of turmeric powder and brownish yellow colour of turmeric oleoresin which gives a yellowish colour on about 10% aqueous dilution. The qualities of turmeric rhizomes for food and medicinal uses are based directly on the content of the curcuminoids and volatile oil [9]. Turmeric rhizomes are exposed to a variety of conditions during processing, packaging and storage, and some of these may have detrimental effects on the stability of the active constituents and consequently on their quality. Some factors affecting the stability of active constituents of turmeric have previously been investigated [10][11]. The content of active constituents could be affected by environmental factors such as temperature, pH, light, moisture and air [12-18].

Presently, The National Root Crops Research Institute, Umudike, Abia State, Nigeria is involved in agronomic production of turmeric genotypes and their distribution to local farmers for multiplication and farm-gate processing. Studies need to be carried out on the quality of the end products during/after processing and their storage behaviours. The objective of this work is to carry out studies on the possible short term storage effect on some chemical properties of locally processed turmeric powder in South-eastern Nigeria

MATERIALS AND METHODS

2.1 Source of materials: Raw rhizomes of turmeric variety NCl 14 were sourced freshly from experimental field trial of Other Root Crops Programme of National Root Crops Research Institute, Umudike, Abia State, Nigeria.

2.2 Processing of turmeric rhizomes into powder: The method described by [9] was used. The method involved sorting, washing, and particle size reduction by longitudinal splitting, drying, milling and sieving. The turmeric samples were dried with the aid of an electric oven: Model: N50C with serial number Y3J039; 240 A.C Volts; 50Hz, 0.75 Kw load and 3amps (GENLAB, WIDNES, ENGLAND) . Drying temperatures for the different experimental treatments were 50˚C, 60˚C and 70˚C. Parameters studied during storage were moisture, pH and colorimetric absorbance at 0.1 and 0.25% concentrations.

2.3 Turmeric Powder Storage: Materials used for storage were sealed transparent low density polyethylene (LDPE), opaque polypropylene and transparent glass bottle. About 200g sample each was stored at room temperature (25ºC ±2) in a cool dark cupboard to avoid sunlight. Duration of storage was six weeks and time of analyses was at two weeks intervals.

2.4 Liquid Extracts of Turmeric Powder : The method described by [9] was used. Hot water extraction (100ºC, pH 7.2) was used to dissolve the powder and allowed to cool till ambient temperature and neutral pH (25ºC ±2ºC, pH 7.0). The solution was filtered using a *muslin* cloth.

2.5 Turmeric powder moisture content determination: The method of [19] was used. The amount of water found in a food sample is influenced by the type of food, age or maturity, variety and geographical location. The moisture content determination gives an indication of the amount of water found in the food substance and thus suggests the keeping characteristics of such foods. A clean weighing petri dish was placed in an oven and dried at 80ºC for about 30 minutes, cooled in a dessicator and weighed (W_o). About 2g of each turmeric sample was weighed into the petri dish and re-weighed (b). The Petri dish with the sample was dried to a constant weight (c) at 70ºC. The determination for each sample was done in triplicate.

Calculation:
W_o = Weight of moisture can
b = Weight of moisture can + sample
c = weight of moisture can + dried sample
b - c = Weight of dried sample
b - W = Weight of wet sample

% Moisture content (MC) $= \frac{b - w}{b - c} \times 100$

2.6 Determination of pH of Turmeric Powder : pH was determined using a Jenway 3015 pH meter as described by [19]. The procedure involved preparing 10% w/v suspension of the sample in distilled water. This was mixed thoroughly in a waring micro-blender and cooled . The pH of triplicate determinations were read and recorded.

2.7 Determination of Colorimetric Absorbance : Colorimetric absorbance readings (in triplicates) were done with the aid of a UV/visible colorimeter (Jenway 6405, England) as described by [19]. A 1cm cuvette was used for the colorimetric analysis to the dilute coloured liquid extracts of the turmeric samples at 420nm wavelength.

2.8 Statistical analysis: Replicated data collected were subjected to analysis of variance (ANOVA) using Statistical Analytical System (SAS) software, version 8. Mean separations were done using Fischer LSD at 0.05% probability [20].

RESULTS AND DISCUSSION

Table 1 shows pre- storage analysis of selected quality parameters of turmeric powder samples. Moisture content ranged from 5.96 – 6.15%; pH 6.83-7.12; colorimetric absorbance at 0.1% concentration 0.39-0.50% and colorimetric absorbance at 0.25% 0.90-1.17%. Moisture content were generally low and showed no significant difference (p>0.05) among the samples. Moisture contents were within recommended standard by Indian Standard Institute [21]

Table 1: Pre- storage analysis of selected quality parameters of turmeric powder samples

Temperature(◦C)	Moisture (%)	pH	Absorbance (0.1%)	Absorbance (0.25%)
50◦C	6.00a	7.10a	0.50a	1.17a
60◦C	5.95a	7.12a	0.39c	0.83c
70◦C	6.15a	6.83b	0.46b	0.90b
LSD at 0.05%	1.09	0.04	0.03	0.05

Mean values down the columns with the same letters are not significantly different (P>0.05) Key:
(i) D50= Sample produced by drying at 50˚C (ii) D60= Sample produced by drying at 60˚C
(iii) D70= Sample produced by drying at 70˚C (iv) Low density polyethylene (LDPE)
(v) Opaque polypropylene and (vi) Transparent glass bottle

The p H values were near neutral pH of 7 levels while absorbance was highest in turmeric produced by drying at 50˚C. However, there was a significant difference (p<0.05) in the colorimetric absorbance of the turmeric samples produced by drying at different temperatures.

Table 2 shows the effect of storage on the moisture contents of packaged turmeric powder samples. Using neat, sealed Low density polyethylene (LDPE) bags, moisture contents of samples produced by drying at 50˚C was lowest at week zero (6.00%) and highest at 6 weeks storage period (14.40%). There was no significant difference (p>0.05) in the moisture contents of turmeric powder samples stored for 2 and 4 weeks. Drying turmeric powder samples at 60˚C showed that moisture was lowest week zero (5.96%) and highest at 6 weeks storage period (15.00%). There was no significant difference (p>0.05) in the moisture contents of turmeric powder samples stored for 2 and 4 weeks. Drying turmeric powder samples at 70˚C showed that moisture was lowest a week zero (6.15%) and highest at 6 weeks storage period (14.30%). There was a significant difference (p<0.05) in the moisture contents of turmeric powder samples stored at different periods. Dried turmeric powder at 50˚C, packaged with a plastic bottle (PB) showed that moisture content was lowest at zero week (6.00%) and highest at 6 weeks (14.50%). There was a significant difference (p<0.05) in the moisture contents of turmeric samples stored at different periods. Drying turmeric powder samples at 60˚C showed that moisture was lowest at week zero (5.96%) and highest at 6 weeks storage period (13.80%).

Table 2: Effect of storage on the moisture content of the packaged turmeric powder samples

		LDPE		PB				GB	
Storage Period (weeks)	**D50**	**D60**	**D70**	**D50**	**D60**	**D70**	**D50**	**D60**	**D70**
0	6.00c	5.96c	6.15d	6.00d	5.95d	6.15d	6.00c	5.95d	6.15c
2	9.80b	9.41b	8.73b	9.77b	9.47c	8.45c	9.25b	7.75c	9.49b
4	10.10b	10.1b	7.15c	8.30c	9.95b	9.45b	9.95b	10.00b	9.60b
6	14.40a	15.0a	14.3a	14.50a	13.80a	13.70a	14.00a	14.05a	12.70a
LSD at 0.05%	**0.97**	**0.94**	**0.29**	**1.00**	**0.10**	**0.10**	**0.94**	**0.03**	**0.21**

Mean values down the columns with the same letters are not significantly different (P>0.05) Key:
(i) D50= Sample produced by drying at 50˚C; (ii) D60= Sample produced by drying at 60˚C
(iii) D70= Sample produced by drying at 70˚C; (iv) Low density polyethylene (LDPE)
(v) Opaque polypropylene and (vi) Transparent glass bottle

There was a significant difference (p<0.05) in the moisture contents of turmeric samples stored at different periods. Moisture contents of turmeric samples produced by drying at 70˚C were lowest at zero week (6.15%) and highest at 6 weeks storage period (13.70%). There was a significant difference (p<0.05) in the moisture contents of turmeric samples stored at different periods. Drying turmeric powder samples at 50˚C, packaged with glass bottles (GB) showed that moisture content was lowest at week zero (6.00%) and highest a 6 weeks (14.00%) storage period. There was no significant difference (p>0.05) in the moisture contents of turmeric powder samples stored at 2 and 4 weeks. Drying turmeric powder at 60˚C showed that moisture was lowest a zero week (5.95%) and highest at 6 weeks storage period (14.05%). There was a significant difference (p<0.05) in the moisture contents of turmeric powder samples stored at different periods.Moisture contents of turmeric powder samples produced by drying at 70°C was lowest at week zero (6.15%) and highest at 6 weeks storage period (12.70%). There was no significant difference ($p>0.05$) in the moisture contents of turmeric powder samples stored at different periods. Moisture contents of turmeric powder samples dried at different temperatures, packaged with different materials and stored for 2 and 4 weeks were within the recommended values of 10% [9]. Fresh turmeric rhizomes is a semi- perishable crop commodity with moisture content > 55%. A maximum of 10% moisture content is required for turmeric powder prior to large scale storage by agro-entrepreneurs or industries [21]. The observed increase in moisture contents as storage weeks increased is in line with the previous findings of [22] in a work titled the content of active constituents of stored sliced and powdered preparations of turmeric rhizomes and zeodary (bulb and finger). In the study, moisture contents of turmeric and zeodary (bulb and finger) rhizomes increased with increasing storage time. Increase in moisture content of turmeric powder may be as a result of its high total surface area and resulting high capacity to absorb water [22].

Table 3 shows the effect of storage on pH of packaged turmeric samples. Using LDPE, pH of samples produced by drying at 50°C was lowest at 4 weeks storage period (4.72) and highest at week zero (7.10). There was no significant difference ($p>0.05$) in the pH of turmeric samples stored for 4 and 6 weeks. Drying turmeric powder at 60°C showed that pH was lowest at week 6 (4.37) storage period and highest at week zero (7.12). There was a significant difference ($p<0.05$) in the pH of turmeric samples stored at different periods. Drying turmeric powder at 70°C showed that pH was highest at zero week (6.83) and lowest at 6 weeks storage period (3.06). There was a significant difference ($p<0.05$) in the pH of turmeric powder samples stored at different periods. Decrease in pH of stored *gari* packaged with low LDPE was also observed by [23]. Fermentation or microbial activity might cause increase in acidity potential.

Packaged samples with plastic bottle (PB); pH of samples produced by drying at 50°C was lowest at 4 weeks storage period (4.53) and highest a 2 weeks (7.10). There was no significant difference ($p>0.05$) in the ph of turmeric sample produced at zero week and that stored for 2 weeks. At 60°C drying temperature, pH was lowest at 6 weeks storage period (4.45) and highest at week zero and 2 weeks storage period (7.12). There was no significant difference ($p>0.05$) in the pH of turmeric samples stored at 2 weeks storage period and that produced at week zero. pH of turmeric samples produced by drying at 70°C was lowest at 6 weeks storage period (4.5) and highest at 2 weeks (7.30). There was no significant difference ($p>0.05$) pH of turmeric samples stored at 4 and 6 weeks storage periods.

Table 3: Effect of storage on the pH of the packaged turmeric powder samples

	LDPE			PB			GB		
Storage Period (weeks)	**50◦C**	**60◦C**	**70◦C**	**50◦C**	**60◦C**	**70◦C**	**50◦C**	**60◦C**	**70◦C**
0	7.10a	7.12b	6.83a	7.10a	7.12a	6.83b	7.10b	7.15a	6.83a
2`	6.84b	7.19a	4.93b	7.13a	7.12a	7.30a	7.37a	7.12a	6.19b
4	4.72c	4.66c	4.65c	4.53c	4.55c	4.59c	4.70c	4.52b	4.58c
6	4.75c	4.37d	3.06d	4.88b	4.45d	4.50c	4.75c	4.43c	4.52d
LSD at 0.05%	**0.10**	**0.03**	**0.05**	**0.10**	**0.03**	**0.21**	**0.14**	**0.04**	**0.04**

Mean values down the columns with the same letters are not significantly different (P>0.05)m Key:
(i) D50= Sample produced by drying at 50°C (ii) D60= Sample produced by drying at 60°C
(iii) D70= Sample produced by drying at 70°C (iv) Low density polyethylene (LDPE)
(v) Opaque polypropylene and (vi) Transparent glass bottle

Packaged samples with glass bottles (GB); pH of turmeric samples produced by drying at 50°C was lowest at 4 week storage period (4.70) and highest at 2 weeks (7.37). There was no significant difference ($p>0.05$) in the ph of turmeric samples stored for 4 and 6 weeks. Drying turmeric powder at 60°C showed that pH was lowest at 6 weeks storage period (4.43) and highest at zero weeks (7.15). There was no significant difference ($p>0.05$) in the pH of turmeric samples stored for 2 weeks and that produced at week zero. The pH of turmeric samples produced by drying at 70°C was lowest at 6 weeks (6.15%) and highest at zero week storage period (6.83). The pH values were within the acidic medium and this may help to prolong the keeping quality of the turmeric samples**.** pH is an important physiological characteristic of a tissue, which is related to the level of acidity/alkalinity due to the release or absorption of hydrogen ions [24].

Table 4 shows effect of storage on absorbance of 0.1% concentration of turmeric powder in solution. Using LDPE as storage material, absorbance of samples produced by drying at 50°C was lowest at 2 weeks storage period (0.38) and highest at week 6 (0.59). Drying turmeric powder at 60°C showed that colorimetric absorbance was highest at week 6 storage period (0.62) and lowest at week zero (0.39). There was no significant difference ($p>0.05$) in the absorbance of turmeric samples stored for 2 and 4 weeks. Drying turmeric powder at 70°C drying showed that colorimetric absorbance was highest at 6 weeks storage period and lowest a 2 weeks (0.42). There was no significant difference (p>0.05) in the colorimetric absorbance of turmeric powder samples stored at 2, 4 weeks and that produced at week zero.

Packaged samples with plastic bottle (PB) showed that colorimetric absorbance of samples produced by drying at 50˚C was lowest at 2 weeks storage period (0.39) and highest at 6 weeks (0.69). There was no significant difference (p>0.05) in the absorbance of turmeric sample stored for 2 and 4 weeks. Drying turmeric powder at 60˚C showed that colorimetric absorbance was highest at 4 weeks storage period (0.49) and lowest at week zero (0.39). Colorimetric absorbance of turmeric samples produced by drying at 70˚C was lowest at 2 weeks storage period (0.38) and highest at 6 weeks (0.54). There was a significant difference (p<0.05) in the colorimetric absorbance of turmeric samples stored at different periods.

Table 4: Effect of storage on the spectrophotometric absorbance at 0.10% concentration of the turmeric powder samples

		LDPE			PB				GB
Storage period (week)	**D50**	**D60**	**D70**	**D50**	**D60**	**D70**	**D50**	**D60**	**D70**
0	0.50ab	0.39c	0.46b	0.50b	0.39c	0.46b	0.50b	0.39c	0.46ab
2	0.38c	0.45b	0.42b	0.39c	0.45ab	0.38c	0.46b	0.50a	0.49a
4	0.44bc	0.44b	0.45b	0.40c	0.49a	0.45b	0.42b	0.41bc	0.43b
6	0.59a	0.62a	0.54a	0.69a	0.44b	0.54a	0.66a	0.45ab	0.49a
LSD at 0.05%	**0.10**	**0.03**	**0.05**	**0.10**	**0.04**	**0.05**	**0.10**	**0.05**	**0.04**

Mean values down the columns with the same letters are not significantly different (P>0.05)Key:
(i) D50= Sample produced by drying at 50˚C (ii) D60= Sample produced by drying at 60˚C
(iii) D70= Sample produced by drying at 70˚C (iv) Low density polyethylene (LDPE)
(v) Opaque polypropylene and (vi) Transparent glass bottle

Packaged samples with glass bottles (GB) showed that colorimetric absorbance of turmeric samples produced by drying at 50˚C was lowest at week 4 storage period (0.42) and highest at 6 weeks (0.66). There was no significant difference (p>0.05) in the colorimetric absorbance of turmeric samples stored at 2, 4 weeks and that produced at week zero. Drying turmeric powder at 60˚C showed that colorimetric absorbance was lowest at week zero (0.39) and highest at 2 weeks storage period (0.50). Colorimetric absorbance of turmeric samples produced by drying at 70˚C was lowest at 4 weeks storage period (0.43) and highest at 2 and 6 weeks (0.49).

Table 5 shows effect of storage on colorimetric absorbance of 0.25% concentration of turmeric powder in solution. Using LDPE as storage material, absorbance of samples produced by drying at 50˚C was lowest at 6 weeks storage period (0.54) and highest at week zero (1.17). There was a significant difference (p<0.05) in the absorbance of turmeric samples stored at different periods. Drying turmeric powder at 60˚C showed that absorbance was lowest at week 4 storage period (0.67) and highest at week zero (0.83). Drying turmeric powder at 70˚C drying showed that colorimetric absorbance was lowest at 4 weeks storage period (0.52) and highest at week zero (0.90). There was a significant difference (p<0.05) in the absorbance of turmeric samples stored at different periods.

Packaged samples with plastic bottle (PB) showed that colorimetric absorbance of turmeric powder samples produced by drying at 50˚C was lowest at 6 weeks storage period (0.63) and highest at week zero (1.17). There was a significant difference (p<0.05) in the colorimetric absorbance of turmeric samples stored at different periods. Drying turmeric powder at 60˚C showed that colorimetric absorbance was highest at 2 weeks storage period (0.86) and lowest at week 4 (0.73). There was a significant difference (p<0.05) in the absorbance of turmeric samples stored at different periods.

Table 5: Effect of storage on the spectrophotometric absorbance at 0.25% concentration of the turmeric powder samples

		LDPE			PB				GB
Storage period (week)	**D50**	**D60**	**D70**	**D50**	**D60**	**D70D**	**D50**	**D60**	**D70**
0	1.17a	0.83a	0.90a	1.17a	0.83ab	0.90a	1.17b	0.83a	0.90a
2	1.07b	0.8ab	0.70b	0.73b	0.86a	0.66c	0.70c	0.81a	0.66d
4	0.63c	0.67c	0.52d	0.67c	0.73c	0.52d	0.67c	0.68b	0.74c
6	0.54d	0.7bc	0.65c	0.63d	0.80b	0.87b	1.85a	0.68b	0.82b
LSD at 0.05%	**0.04**	**0.10**	**0.03**	**0.05**	**0.04**	**0.03**	**0.06**	**0.04**	**0.04**

Mean values down the columns with the same letters are not significantly different (P>0.05)Key:
(i) D50= Sample produced by drying at 50˚C (ii) D60= Sample produced by drying at 60˚C
(iii) D70= Sample produced by drying at 70˚C (iv) Low density polyethylene (LDPE),
(v) Opaque polypropylene and (vi) Transparent glass bottle

Colorimetric absorbance of turmeric powder samples produced by drying at 70˚C was lowest at 4 weeks storage period (0.52) and highest at week zero (0.90). There was a significant difference (p<0.05) in the absorbance of turmeric samples stored at different periods.

Packaged samples with glass bottles (GB); absorbance of turmeric samples produced by drying at 50°C was lowest at week 4 storage period (0.67) and highest at week zero (1.85). There was a significant difference ($p<0.05$) in the absorbance of turmeric samples stored at different periods. Drying of turmeric at 60°C drying showed that absorbance was lowest at weeks 4 and 6 (0.68) and highest at week zero (0.83). There was no significant difference ($p>0.05$) in the absorbance of turmeric samples stored for 2 weeks and that produced at week zero. Colorimetric absorbance of turmeric samples produced by drying at 70°C was lowest at 2 weeks storage period (0.43) and highest week zero (0.90). There was a significant difference ($p<0.05$) in the absorbance of turmeric samples stored at different periods. Values of colorimetric absorbance reported on tables 4 and 5 were within the values previously reported by [8]. The yellow-orange colours (though darker in the ones dried at 50ºC were stable across storage periods. The stability may be attributed to the acidic pH in the stored samples. Hot water may seemed to be a better extract media of the turmeric colour pigments over cold water and alkaline pH could vary the colour of hot Nigerian turmeric rhizomes to red-brown coloration [9]. This is in line with the report of [10] that Turmeric extractives, or oleoresins, are obtained by solvent extraction of the powdered rhizome. The process yields about 12 % of an orange/red viscous liquid which, depending on the solvent used for extraction and on the turmeric type and cultivar, contains various proportions of the colouring matter, that is, the curcuminoids, the volatile oils which impart the flavour to the product, and non-volatile fatty and resinous materials. Curcuminoids, the colour constituents of turmeric, deteriorate with light and to a lesser extent, under heat and oxidative conditions [11], it is important that ground turmeric be packed in an ultra violet (UV) protective packaging and appropriately stored.

CONCLUSION

Drying turmeric at 50°C, 60°C and 70°C during the production of turmeric powder and packaging maintained their quality parameters in-terms of absorbance and pH. The study recommends 4 weeks storage periods for turmeric powders dried at 50°C, 60°C and 70°C and with the packaging materials used. The 4 weeks recommendation within the scope of this study was due to the significant increase in moisture at 6 weeks storage periods as this may cause spoilage due to activity microbes as days of storage extend. It is known that Curcumin is highly sensitive to light and alkaline pH, and is also degraded by heat and chemical oxidants. It is therefore not easy to use in food processes and products destined to long-term storage. It is nevertheless of commercial interest as a natural food colorant. More research can be done to optimize the processes employed which may help to improve on the turmeric storage potential. Nigeria should consider parboiling turmeric rhizomes before drying and conversion to powder. Boiling the rhizomes until soft gelatinizes the starch for a more uniform drying and to remove the fresh earth odour. Also, boiling makes the colouring material to diffuse uniformly through the rhizomes. However, the Indian Institute of Spice Research, Calicut, Kerawa simply recommends boiling in water for 45 minutes to 1 hour until forth appears at the surface and typical turmeric aroma is released.

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