Sky Journal of Agricultural Research Vol. 5(5), pp. 087 - 090, July, 2016
Available online http://www.skyjournals.org/SJAR
ISSN 2315-8751 ©2016 Sky Journals

Full Length Research Paper

Effect of stage of maturity at harvest on the quality of different accessions of turmeric (*Curcuma domestica* Val) in Southwestern Ethiopia

Girma Hailemichael[1]*, Amsalu Nebiyu[2], Ali Mohammed[2], Derbew Belew[2] and Digafie Tilahun[1]

[1]Tepi National Spices Research Center, P. O. Box, 34, Tepi-Ethiopia.
[2]Jimma University College of Agriculture and Veterinary Medicine, P. O. Box, 307, Jimma, Ethiopia.

Accepted 30 May, 2016

An experiment was conducted to investigate the effect of harvesting stages on quality of turmeric. Three accessions of turmeric with five harvesting stages were evaluated in a factorial combination. Samples (1 kg each) were harvested, dried and quality parameters were recorded. The analysis indicated that moisture content was significantly ($p < 0.01$) influenced by accessions and harvesting stages. The lowest moisture content (74.3%) was attained from Pack.6/82 harvested 8 months and the highest moisture content (78.81%) was attained from Bonga.51/71 harvested 11 months after planting. The highest essential oil content in fresh (1.21%) and in dried rhizomes (5.13%) was recorded from Bonga.51/71 harvested 7 months after planting. On the other hand, oleoresin content was significantly influenced ($p < 0.05$) by cultivar. The highest oleoresin content in fresh (2.77%) and in dried rhizomes (11.45%) was obtained in Bonga.51/71. The results of the present study showed that accession Bonga.51/71 and cultivar Dame (Ind.48/72) were superior with respect to major quality parameters indicating the potential for export provided that recommended harvesting and processing methods applied. The accessions showed higher quality performances when harvested from 7 to 8 months after planting and is recommendable for producers for extraction and export.

Key words: Cultivars, harvesting stages, quality, oleoresin, volatile oil, curcumin.

INTRODUCTION

The spice turmeric constitutes boiled, dried, cleaned and polished rhizomes (the underground swollen stems of plant) of *Curcuma longa* Linn. syn. *C. domestica* Val. The plant is herbaceous, perennial, 60 - 90 cm long with a short stem and tufted leaves, is a native of India and possibly China, and is now a commercial crop of tropics (Purseglove et al., 1981; Pruthi, 1998). Quality parameters such as physical appearance, color and extraction content (oleoresin and essential oil) are very important factors to be considered in turmeric production as does in all other spices.

Quality of cured turmeric is assessed on the basis of several factors. These include the general appearance, size and physical form of the rhizome, the pigment (curcumin) content, the organoleptic (look, smell and taste) character. The relative importance of these various quality attributes is dependent upon the intended end-use of the product (Pursegove et al., 1981; Pruthi, 1998). As in different spices (Borget, 1993; Purseglove et al., 1981; Pruthi, 1998), quality of turmeric could be influenced by the variety cultivated, environmental conditions of growing area (rain fall quantity and distribution, temperature), soil factors, harvesting stage at maturity and finally the processing and/or drying and packaging and storage of the product. Borget (1993), Plotto (2005), Purseglove et al. (1981) and Pruthi (1998) stated that the principal quality determinants of turmeric, i.e., the pigment volatile oil and bitter principle contents, are mainly governed by the intrinsic characteristics of the cultivars grown and the stage of maturity of the rhizome at harvest.

Turmeric thrives best in the hot humid agro ecology. It

*Corresponding author. E-mail: girmah2003@yaoo.com

performed very well in different locations of southwestern Ethiopia being very common and important cash crop for farmers and large scale producers (Edossa, 1998; Girma et al., 2008a). According to the second growth and transformation plan (GTPII) of the Ministry of Agriculture and Natural Resource, the production plan of dry turmeric in 2015/16 was 22750 ton and is planned to grow to 31910 ton by 2020 (MoANR, 2016). From results of long period evaluation, average dry rhizome yield of turmeric accessions at Tepi National Spices Research Center was reported to be 4.2 to 5.3 ton per hectare and at farmers field is 3.2 to 4.2 ton per hectare. And significant numbers of farmers in southwestern Ethiopia have been proving the benefit they are getting from this spice is very valuable, change in their livelihood to a relatively higher level has been attained. However, the very challenging part of turmeric production is its quality that could be governed by the cultivar grown and the stage of maturity of the rhizomes at harvest as production and processing of this spice remained very traditional in Ethiopia. As stated above the bottleneck in turmeric production is absence of preparation of quality turmeric that can compete in local and international markets. Fantahun and Teklu (1995) discussed that the traditional processing practices carried out by growers are the main factors for inferior quality spice products in Ethiopia. One of the main contributing factors for this low quality product has been absence of appropriate harvest stage (months) to get the optimum extraction yields (oleoresin and volatile oil content) and other quality parameters. KAU (2002) reported that in India the time of harvest depends on variety (maturity group) and usually from January to March is ideal period for harvesting. The report classified harvesting stage of varieties in maturity groups, i.e., early varieties 7-8 months, medium varieties 8 -9 months and long duration varieties 9 - 10 months after planting. In our country such important package recommendation on harvesting stage versus quality for turmeric production has not been studied and recommended. At the same time three private turmeric processing and packing industries started the business around the potential producing areas and recommendation on suitable harvesting stages has been very important. Therefore this experiment was conducted with the objective of identifying the suitable/optimum time (months) of harvesting to obtain optimum quality requirements of the two accessions and one turmeric cultivar.

MATERIALS AND METHODS

This experiment was conducted in Tepi National Spices Research Center, 1200 m above sea level, annual rain fall of 1755 mm (seven years average), and minimum and maximum temperature of 15.5 and 29.5ºC, respectively (Girma et al., 2008b). Soil type of the experimental site is classified as Nitisols and Fluvisols with minor occurrence of Leptosols with pH value of 6.9 to 8.0 (neutral to moderately alkaline) (Abayneh and Ashenafi, 2005) which is dominated by a loam texture. The experiment land was ploughed three times until the soil became very fine. Three accessions of turmeric: Pack.6/82, Bonga 51/71 and Ind.48/72 (Dame) were used in this experiment. The accessions were collected before about 30 years and Dame is an improved cultivar by selection. Seed rhizomes of the three accessions and/or cultivar were prepared according to the recommended seed size and planted in recommended season (mid of March) and all cultural practices of field management were applied as per the recommendation. Harvesting was started when the first harvest treatment (7 months reached attained). Other harvesting treatments continued accordingly with monthly interval till 11^{th} month. Treatments of 3 accessions and 5 harvesting stages (7, 8, 9, 10 and 11 months after planting) were arranged in factorial combination. The design was Randomized Complete Block Design (RCBD) with three replications. A sample of one kg fresh rhizome turmeric was harvested from each plot. The samples were washed, boiled for 45 - 60 min, dried for 1 - 15 days in the sun till they attained the recommended moisture level (12 - 13%) and peeled with polisher. The samples were sent to Essential Oil Research Center Laboratory (Addis Ababa) to run quality analysis. Data from fresh material were recorded and samples were dried in sunlight for the dry basis recording. Data on quality of turmeric such as percent ash content, moisture content, oleoresin and volatile oil (essential oil) content were analyzed using standardized techniques of analysis (AOAC, 1984).

Statistical analysis

Data for each parameter were subjected to ANOVA by the General Linear Models procedure using SAS (Statistical Analysis System, 2008, SAS Institute, Cary, N. C.). Mean comparison was performed using the Duncan's Multiple Range Test (DMRT) method. A significant level of 5% was used for all statistical analyses.

RESULTS AND DISCUSSION

Physical quality parameters of the dried turmeric rhizomes were recorded (Table 1). The results indicated that rhizomes harvested from 7^{th} to 8^{th} months after planting were not in good appearance (very shrink), small in size, and with brownish-yellow color. These rhizomes were highly recommended for extraction purpose. Whereas, turmeric rhizomes harvested from 9^{th} month and more showed a good appearance for observer. The final uses of such harvests were more recommended for whole rhizome use and with possible extraction. The

Table 1. Physical observation records and summarized parameters of dried rhizomes of turmeric (*Curcuma domestica* Val) accessions and/ or cultivar at different harvest stages.

Harvesting stages (months)	Status of dried rhizomes	Size of rhizomes (cm)*	Colour	Product preference
7	Very shrink	Small	Brownish-yellow	Extraction
8	Very shrink	Small	Brownish-yellow	Extraction
9	Medium shrink	Medium	Yellow	Whole-use, extraction
10	Slender	Large	Deep-yellow	Whole-use, extraction
11	Slender	Very large	Deep-yellow	Whole-use, extraction

* Small< 3, medium 3.1-6, large 6.2-9 and very large>9. .

Table 2. Qualitative parameters of turmeric as influenced by accessions and/or cultivar and harvesting stage after planting.

Accessions and/or Cultivars	Moisture content (%)	Volatile oil content (%) v/w (wet basis)	Volatile oil content (%) v/w(dry basis)	Oleoresin content (%) w/w(wet basis)	Oleoresin content (%) w/w (dry basis)
1. Bonga 51/71	76.490	1.08	4.42	2.70	11.19
2. Pak.6/82	76.978	1.09	4.51	2.77	9.46
3. Ind.48/72 (Dame)	77.550	1.09	4.60	2.77	11.60
CV (%)	1.05	10.16	10.46	24.19	11.64
$LSD_{0.05}$	NS	0.247	NS	NS	NS
Harvesting stages (months)					
7	77.233	1.02	4.28	2.75	11.19
8	75.990	1.16	4.62	2.42	9.46
9	76.510	1.12	4.50	2.97	11.60
10	77.310	1.05	4.44	2.88	11.64
11	78.810	1.08	4.70	2.73	11.46
CV (%)	1.05	10.16	10.46	12.44	13.55
$LSD_{0.05}$%	NS	0.36	0.14	0.27	1.2
Cultivar X Harvesting stages	NS	NS	NS	NS	NS

NS= non-significant

results support the general truth reported by Purseglove et al. (1981). The authors reported that spices at late harvest mostly result in more uniform and good appearance but with low quality. The reverse also happens with early harvest that mostly recommended for extraction purpose (industry).

Essential oil content (%) of fresh turmeric (*C. domestica*) samples were significantly influenced ($p < 0.05$) due to the accessions and/or cultivar used; and no significant effect was observed on moisture content (%), volatile oil content (%) on dry basis and oleoresin content (%) on wet and dry basis due to accessions and/or cultivars (Table 2). The second most important factor, harvesting stage significantly affected volatile oil content (%) for both samples as received (fresh) and dry weight basis ($P \leq 0.05$) and oleoresin content both at wet and dry basis whereas moisture content (%) was not significantly affected by different harvest stages. Harvesting stage significantly affected quality of turmeric as essential oil, oleoresin and other quality parameters of turmeric varied because of different harvesting stage (Purseglove et al., 1981; Pruthi, 1998; Girma and Digafie, 2008). Pachauri et al. (2002), Kumar and Gill (2009) also discussed that harvesting stage significantly influenced oil content of turmeric as it increased through late harvesting. Significant quality loss of turmeric could be attained due to either early harvest of rhizome when it is not mature or over mature in addition to different management gaps (Suresh et al., 2007).

Volatile oil content (%) and oleoresin content on dry basis which are the very important quality parameter for turmeric product were not significantly affected due to accessions and/or cultivar. However, the released cultivar Ind.48/72 (Dame) gave maximum volatile oil content % (v/w) and oleoresin content % (w/w) 4.60 and 2.77, respectively. Next, volatile oil content % (v/w) and oleoresin content % (w/w) 4.51 and 2.77, was recorded from accession Pak.6/82. The fact that significant effect was not obtained on these quality parameters due to accessions and/ or cultivar was a different effect to the reports from (Girma and Digafie, 2008; Purseglove et al., 1981; Pruthi, 1998). Even if there was no statistical significance, maximum oleoresin content % (w/w) 11.60 and 11.19 were recorded from the released cultivar Dame (Ind.48/72) and accession Bonga51/71, respectively while Edossa (1998) reported the same

materials gave 18.0 and 13.7 oleoresin yield, respectively. According to Garg et al. (1999) percent essential oil content of 27 accessions of turmeric rhizomes varied between 0.16% to 1.94% and 0.64& to 7.76% on wet and dry basis, respectively. Raghavan (2007) also reported that turmeric contains 1.5% to 6% essential oil while volatile/essential oil content % (v/w) of the current research ranged from 1.08 - 1.09 and 4.42 - 4.60 in the wet and dry basis, respectively. Variability of quality (volatile oil and oleoresin content) due to accessions and/or cultivar was more emphasized by Purseglove *et al*. (1981) and Girma et al. (2008b) also reported that even if statistical significance was not obtained; mean (%) yield of both volatile oil and oleoresin varied due to accessions and/or cultivars of ginger. Similarly, there was variability in mean oleoresin and volatile oil among accessions and/or cultivar even if no significance, otherwise the current study indicated that most of the quality parameters except moisture content were significantly affected by harvesting stage which is very supportive to the reports of many reviewers (Girma and Digafie, 2008; KAU, 2002, Purseglove et al., 1981).

Generally, results of the present study showed that accessions and/or cultivar Bonga.51/71 and Dame (Ind.48/72) were consistently superior with respect to the major quality parameters indicating the potential of these materials for export provided that growers follow the recommended harvesting and processing methods. As well, 7 - 8 months after planting was found more ideal for these accessions and/or cultivar in order to produce quality turmeric in Ethiopia to support the private processors.

Conclusion

Harvesting stage of the turmeric rhizomes significantly influenced more of the quality parameters. In general, the accessions showed higher quality performances when harvested from 7 to 8 months after planting and is recommendable for producers for extraction and export.

Acknowledgements

The authors would like to acknowledge Ato Awoke Endre, Aschalew Bekele and Ahmed Husein for unreserved contribution in field operation and the Ethiopian Institute of Agricultural Research for funding the research project.

REFERENCES

Abayneh E, Ashenafi A (2005). Soils of Tepi and Haru Agricultural Research Sub-centers, Soil survey and land evaluation section. National Soil Research Center, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

AOAC (1984). Official Methods of Analysis. 11th ed. Association of Official Analytical Chemists, Washington, DC.

Borget M (1993). Spice Plants. The Tropical Agriculturalist. CTA, Macmillan London.

Edossa E (1998). Spices research achievements and experiences, Research report No. 33. Institute of Agricultural Research, Addis Ababa Ethiopia, pp. 4-25.

Fantahun L, Teklu N (1995). Spices crops processing: Constraints and Possibilities; Workshop on Coffee and Associated Crops, Feb. 27 - March 1/1995. Addis Ababa, Ethiopia, pp.1-10.

Garg SN, Bansal RP, Gupta MM, Kumar S (1999). Variation in the rhizome essential oil and curcumin contents and oil quality in the land races of turmeric (*Curcuma longa*) of North Indian plains. Flavour Fragr. J., 14: 315-318.

Girma H, Digafie T (2008). The effects of stage of maturity at harvest on the quality of five pepper (*Piper nigrum* L.) cultivars, In: Lemma D, Endale G, Hailemichael K, Zenebe W, Terefe B, Asfaw Z, Lakew B (eds.) Ethiopian Horticultural Science Society (EHSS), Volume I. Proceedings of the first inaugural conference, 23-24 March 2006, Addis Ababa, ETHIOPIA, pp. 211-214.

Girma H, Digafie T, Edossa E, Belay Y, Weyessa G (2008a). Spices research achievements, revised edition, Ethiopian Institute of Agricultural Research, Addis Ababa Ethiopia, pp. 34-42.

Girma H, Digafe T, Wondyfraw T (2008b). Yield and quality evaluation of ginger (*Zingiber officinale* Rosc) collections and introductions, In: Lemma D, Endale G, Hailemichael K, Zenebe W, Terefe B, Asfaw Z, Lakew B (eds.) Ethiopian Horticultural Science Society (EHSS), Volume I. Proceedings of the first inaugural conference, 27-30 March 2006, Addis Ababa, ETHIOPIA, pp. 215-220.

Kerala Agricultural University (2002). Package of practices recommendations: Crops. 12th Edition (eds. A. I. Jose *et al*.). Kerala Agricultural University, Trichur.

278p.http://www.kau.edu/pop/spices&condiments.htm

Kumar B, Gill BS (2009). Effect of method of planting and harvesting time on growth, yield and quality of turmeric (*Curcuma longa* L.). J. Spices and Aromatic Crops, 18 (1): 22–27.

Ministry of Agriculture and Natural Resource (MoANR) (2016). Coffee, Tea & Spices Growth and Transformation Plan (GTPII) for the period 2015-2020, pp. 7-9.

Pachauri G, Pandey V, Rai SK, Katiyar RS, Dixit BS, Banarji R, Singh SP (2002). Curcumin content in relation to date of harvesting in turmeric (*C. longa* L.). Indian J. Pl. Gen. Res. 15: 72-73.

Plotto A (2005). Turmeric: Post-production management for improved market access for herbs and spices, FAO http://www.fao.org/inpho/content/compend/text/ch27/ch27_02.htm#2_1

Purseglove JW, Brown EG, Green CL, Robins SRJ (1981). Spices: Volume 2, Longman Group Limited, London.

Pruthi JS (1998). Major spices of India Crop management post-harvest technology (reprinted), Indian Council of Agricultural Research (ICAR), India.

Raghavan S (2007). Handbook of spices, seasonings and flavourings, Second Edition, CRC Press, Taylor and Franchis Group, Boca Raton, London, New York.

S.A.S. Institute Inc. (2008). SAS. STAT user`s guide released version 9.2 SAS institute Inc. Cary.

Suresh D, Manjunatha H, Srinivasan K (2007). Effect of heat processing of spices on the concentrations of their bioactive principles: Turmeric (*Curcuma longa*), red pepper (*Capsicum annuum*) and black pepper (*Piper nigrum*). J. Food Comp. Analys. 20 (3-4): 346-351.