Industrial Crops and Products 95 (2017) 50–59

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

Preponderance of cumin (*Cuminum cyminum* L.) essential oil constituents across cumin growing Agro-Ecological Sub Regions, India

P.N. Dubey, S.N. Saxena*, B.K. Mishra, R.K. Solanki, M.K. Vishal, B. Singh, L.K. Sharma, S. John, D. Agarwal, A. Yogi

ICAR-National Research Centre on Seed Spices, Tabiji, 305206, Ajmer, Rajasthan, India

ARTICLE INFO

Article history:
Received 20 July 2016
Received in revised form 4 October 2016
Accepted 5 October 2016

Keywords:
Cuminum cyminum
Agro-ecological sub-regions
Chemical composition
Essential oil
Cuminaldehyde
Phenolics
Antioxidants

ABSTRACT

Cumin seeds were collected from agro-ecological sub-regions comprising of major cumin growing areas of Rajasthan and Gujarat state, India, to analyze chemical composition of essential oil. The study area was located between the geographical co-ordinates 21°78′ 32″N, 71°33′85″E to 26°21′ 28″ N, 74°37′61″ E. Maximum and minimum EO yield (35.9–28.4%) were obtained in cumin from AESR 2.4 and 5.1 respectively. GC–MS analysis of EO indicated the preponderance of terpenic hydrocarbons in the AESR 2.4 (53.85%) and decrease in AESR 2.1 (32.62%) while cuminaldehyde content was more (39.90%) in AESR 4.2 and less (25.84%) in 2.4. The prominent terpenic compounds included γ-terpinene, β-pinene, santolina triene, α-terpinene, α-pinene and β-thujene, the concentration of these compounds varied with AESRs. Cumic alcohol (10.33–14.40%), anethol & estragol (4.03–9.15%) were the major alcohols with cymol (2.9–4.26%) and geraniol (0.02–2.39%) in traces. Total phenolic content in the various AESRs ranged from 41.50 (AESR 5.1) to 58.61 mg GAE g^{-1} seeds (AESR 2.3) while the flavonoid content in the AESRs ranged between 27.14–36.03 mg QE g^{-1} seeds, being least in 4.2 and highest in 5.1. The study revealed that the average radical scavenging percentage of methanol seed extract does not vary with the different AESRs (94.98–99.05%), as well as EC_{50} value is also same (15.31–15.38 mg BHTE) for samples from different AESRs. Cumin from the AESRs with favourable minimum and maximum temperature and rainfall showed high cuminaldehyde bearing pleasant aroma whereas the AESRs with biotic/abiotic stresses showed higher terpenic compounds with increased pungency.

1. Introduction

Cumin (*Cuminum cyminum* L.), a very important seed spice is known world over for its aromatic and medicinal values. Though origin of cumin (*Cuminum cyminum* L. Family *Apiaceae*) still needs to be located, based upon cited literature its journey can be traced from northern Africa, via west Asia to Central Asia. It is one of the oldest cultivated medicinal food herbs in Asia, Africa and Europe. Apart from India cumin is mostly grown in Morocco, Turkey, Syria, Greece, Egypt and the southern part of the Mashhad province, Iran (Kumar et al., 2015). Among the chief cumin exporters are India, Syria, Pakistan and Turkey, while India and the USA are main cumin oil producers (Sharma et al., 2016). Cumin and its industrially important processed products viz. essential oil and oleoresins accounts for 20–30% of the total Indian spice exports. In total, export volume during 2014–2015 was 155,500 t with a value of 306.37 million USD (Spice Board of India, 2015).

Cumin raw seeds are used in cooking, whereas, volatile oil is good for flavouring foods mainly soups, meats, cheese, pickles, bread etc., and also used in cosmetics and perfumery industries. The fragrance component of the oil is used in creams, lotions, and perfumes, and few instances used to balance the volatile oil content of oleoresin in food processing industries (Rathore et al., 2013). There are number of medicinal uses which helps in curing various diseases (Pandey et al., 2015). In Ayurvedic system of medicine, dried cumin seeds are considered as thermogogue, invaluable for digestion, it also helps to burn toxins and enhances the appetite. Rathore et al. (2013) and Muthamma et al. (2008) while reviewing potential health benefits of seed spices mentioned that cumin possess the property of enhancing appetite, taste perception, digestion, vision, strength, and lactation. It is also used to cure fever, diarrhoea, vomiting, abdominal distension, edema and puerperal disorders. The seeds of cumin contains substantial amount of phenolics and thus acts as excellent antioxidant source (Sharma et al., 2016). Many researchers have attempted to analyze composition of

* Corresponding author.
E-mail addresses: shail.nrcss@gmail.com, shail.saxena@rediffmail.com (S.N. Saxena).

http://dx.doi.org/10.1016/j.indcrop.2016.10.011
0926-6690/

Table 1
Location co-ordinates and weather parameters of the cumin growing AESRs.

S.No.	AESR units	Location co-ordinates	Elevation (M, MSL)	*Temperature during cropping season (°C)		*Mean Annual Rainfall (mm)
				Min.	Max.	
1	2.1	25°11′ 50" N, 71°43′ 19" E to 27°13′38" N, 72°49′ 23" E	53–286	12.38	29.76	299.20–346.15
2	2.3	23° 53′ 39" N, 72°05′ 66" E to 27°04′ 85" N, 73°49′ 29" E	36–392	12.02	30.01	495.65–640.15
3	2.4	23° 34′ 69" N, 69°77′ 29" E to 24°18′ 62" N, 71°11′00" E	85–112	16.63	30.59	450.05–532.08
4	4.2	26°03′ 29" N, 74°46′ 10" E to 26°21′ 28" N, 74°37′61" E and 22°45′ 06" N, 71°65′ 63" E to 23°28′ 71" N, 71°79′34" E	83–472	16.31	32.01	517.15–524.65
5	5.1	21°78′ 32" N, 71°33′85" E to 22°01′18" N, 71°88′ 54" E	110–124	16.35	33.04	520.22–532.81

*Source: Climate data by National Innovations in Climate Resilient Agriculture, (NICRA); ICAR-Central Research Institute for Dry Land Agriculture, Hyderabad.

cumin seed in terms of proximate analysis and EO profiling. They found cuminaldehyde, terpinenes, polyphenols and flavonoids as major components, which may be acting as source for dietary, biologically active and medicinally important compounds (Pandey and Goswami, 2000; Qinqin et al., 2013). Antioxidant activity (AOA) is one of the valuable functional activities of cumin which inhibits lipid peroxidation as compared to synthetic Butylated Hydroxyl Toluene (BHT) (Allahghadri et al., 2010). Though, the crop is limited to middle Asia, India and Indian sub continent but it has great potential for industrial use in various forms world over. In India, cumin is prominently grown in the arid and semi-arid regions of Rajasthan and Gujarat which have favourable soil and climatic conditions for its cultivation. These areas are covered under the Indian Agro-Ecological Sub Regions (AESR) 2.1, 2.3, 4.2 and 2.3, 2.4, and 5.1 covering states of Rajasthan and Gujarat. The area and production these leading states ie., Gujarat and Rajasthan accounts to 6.9 Lakh ha and 4.45 Lakh tonnes, respectively (Spice Board of India, 2015). Quality of cumin seeds grown in Agro-Ecological Sub Regions (AESR) 2.1, 2.3, 4.2 (Rajasthan) 2.3, 2.4, and 5.1 (Gujarat) may be different in terms of flavour and physical characteristics due to different climatic conditions. Cumin from AESR 2.1 and parts of 2.3 is preferred by consumers in Indian market and attracts more prices than cumin from other areas. In international market also Indian cumin has preference over other cumin producing countries. The cumin variety GC-4 is mainly cultivated in India due to its wide suitability to agro-climatic conditions. Objective of present study was to analyze the cumin seeds from different AESRs so as to demarcate the variation in intrinsic quality parameters viz. EO and its constituents in view of prevailing climatic conditions. For present study samples were collected from major cumin growing areas of Gujarat and Rajasthan to classify them as per AESRs of Rajasthan and Gujarat. These samples were evaluated for their EO content, its composition, phenols, flavonoids and antioxidant capacity. Attempts have also been made to understand the effect of stressed environment on aroma bearing constituents cuminaldehyde and tri terpinenes which may vary with the agro-eco-climatic conditions of respective AESRs.

2. Materials and methods

2.1. Plant material

In India, *Cuminum cyminum* L. is the only cultivated species of cumin. It is cultivated in western plains during winters commencing from November to March end. Western arid and semi arid pocket of the country suits well to the ecological need of the crop, being a low input responsive crop it performs well in the marginal lands of the regions with limited nutrient application. In the present study, assuming all the general factors in common including cultivation practices, variety, post harvest handling etc, random sampling was done of cumin seeds at the time of harvesting from farmers field to assess the quality variation with respect to location or environment which is classified as per AESR given in Table 1. Fresh harvest available during April month was collected directly from farmer's fields from GPS tagged sites (Table 2). The Districts covered for the study were Ajmer, Barmer, Jaisalmer, Jalore, Jodhpur, Nagaur, Pali of Rajasthan and Banaskantha, Kuchchh, Patan, Surendranagar and Amreli of Gujarat, India. These collected samples were air dried before processing (removal of extraneous matter) and storage at 4 °C for further analysis.

2.2. The AESRs

Agro-Ecological Region (AER) is the land unit carved out of Agro-Climatic Region (AGR) by superimposing land form and soil conditions that act as modifiers of the Length of Growing Period (LGP) into AGR. In preparation of AESR maps the soil map is superimposed on bioclimatic map and LGP data using Geographical Information System (GIS) tools. India has 20 AER and 60 Agro-Ecological Sub Regions (AESRs) which is incorporated with the information for mean monthly temperature, monthly precipitation, soil type and LGP (Velayutham et al., 1999). Cumin is only cultivated in arid and semi arid regions of Rajasthan and Gujarat covered under the AESRs 2.1, 2.3, 2.4, 4.2 and 5.1 respectively. The location specific average rainfall and average temperature data has been incorporated with the values derived from 1971 to 2011 meteorological data (Table 1). Following are the descriptions of each AESR based on agro-climatic conditions (Fig. 1):

AESR-2.1- Marusthali hot, hyper arid ESR with shallow and deep sandy desert soils, rainfall 299.20–346.15 mm, very low available water holding capacity (AWC) and LGP < 60 days (Jaisalmer, Barmer and Jodhpur).

AESR-2.3- Rajasthan Bagar, North Gujarat Plain and South-Western Punjab Plain, hot typic- arid ESR with deep, loamy desert soils, rainfall 495.65–640.15 mm (inclusion of saline phase), low AWC and LGP 60–90 days [Nagaur, Pali and Jalore (Rajasthan); Banaskantha and Patan (Gujarat)].

AESR-2.4- South Kuchchh and North Kathiawar Peninsula, hot arid ESR with deep loamy saline and alkali soils, rainfall 450.05–532.08 mm, low AWC and LGP 60–90 days (Kuchchh).

AESR-4.2- North Gujarat Plain (inclusion of Aravalli range and East Rajasthan Uplands), hot dry semiarid ESR with deep loamy gray brown and alluvium-derived soils, rainfall 517.15–524.65 mm, medium AWC and LGP 90-120 days, [Ajmer (Rajasthan) and Surendra Nagar (Gujarat)].

AESR-5.1- Central Kathiawar Peninsula, hot, dry semiarid ESR with shallow and medium loamy to clayey black soils (deep black