Investigating the phytochemical, flavour and sensory attributes of mature and microgreen coriander (*Coriandrum sativum*)

MARIA JOSE ORUNA-CONCHA[1], Stella Lignou[1], Emma L. Feeney[2], Karen Beegan[2], Owen Kenny[2] and Niamh Harbourne[2]
[1] *Department of Food & Nutritional Sciences, University of Reading, RG6 6AR, Reading, UK*
[2] *Institute of Food & Health, University College Dublin, Belfield, Dublin 4, Ireland*

Abstract

Microgreens, young stem and leaves of growing plants, have recently been the subject of much interest due to their higher concentrations of nutritive and purported bioactive compounds in comparison to their mature plant counterparts. However, there is currently limited information available in relation to the flavour and sensory attributes of microgreen species, which may ultimately prove important in determining consumer acceptance. This paper reports the total phenolic, carotenoid and chlorophyll contents as well as the aroma volatile profile and sensory attributes of both mature and microgreen coriander. Microgreen coriander was shown to contain significantly higher levels of phenolic compounds, elevated concentrations of terpenes as the main aromatic compounds and a more intense bitter/sweet taste characteristics compared to the mature coriander.

Introduction

The term ‘microgreen’ is generally used to describe young (7 – 21 days) stem and leaves of growing plants [1]. In recent years, microgreens have become a growing trend in the food industry due to their nutritional density and ease of growth. These small but powerful greens have been shown to contain higher concentrations of vitamins, minerals, and phytonutrients than their mature counterparts [2,3] and continue to increase in popularity due to their appealing appearance and use as a flavourful, edible garnish.

Microgreens are considered a novel crop and therefore not much scientific information is available. Previous research on microgreens has shown that the chemical composition has a major impact on its acceptability. As such, it has been shown that sugars, phenolics and other non-volatile compounds (such as ascorbic acid) are important in microgreens as per their direct correlations to consumer preference and overall eating quality [4]. However, there is very little published research on the flavour profile of plants specifically on their microgreen stage.

Experimental

Materials

Mature coriander (MC) and microgreen coriander (MGC) were obtained from McCormack Farms Ltd (Co. Meath, Ireland). Sensory evaluation was carried out in fresh samples. Coriander leaves were plucked from the stem, washed and air-dried before presenting them to the panellists. Micro coriander leaves were prepared in the same way. For the remaining analysis, the herbs were harvested and immediately freeze-dried. Solvents and authentic compounds were purchased from established laboratory chemical suppliers.

B. Siegmund & E. Leitner (Eds): Flavour Sci., 2018, Verlag der Technischen Universität Graz
DOI: 10.3217/978-3-85125-593-5-36, CC BY-NC-ND 4.0

Analysis of volatile compounds

The extraction of volatile compounds was performed using a headspace solid-phase microextraction system (HS-SPME). A 50/30 µm divinylbenzene (DVB)/polydimethylsiloxane (PDMS) fibre (Supelco, Bellefonte, Pennsylvania, USA). Freeze-dried herb (0.5g) reconstituted in 4.5mL of water containing 5000 ng of IS propyl propanoate were placed in a SMPE vial of 15 mL fitted with a screw cap. After equilibration at 40°C for 10 min, the fibre was exposed to the headspace above the sample for 30 min. The sample was kept under stirring at 40°C and desorpted for 20 min in the GC injector at 230°C and analysed by GC-MS as described by Morales-Soto et al. [5].

Analysis of free amino acids

Free amino acids were analysed using the EZ-Faast amino acid derivatisation technique (Phenomenex, Torrance, CA) followed by GC-MS analysis, as described by Elmore et al. [6]. For each plant sample, 0.2 g of freeze-dried powder was weighed in glass vials and suspended in 10 mL of 0.01 M HCl. The suspensions were stirred for 15 minutes with a magnetic stir bar and plate. After standing for 15 minutes, 2 mL of the supernatant was removed and placed into Eppendorfs that were centrifuged for 15 minutes at 12,100g in a MiniSpin Eppendorf centrifuge.

Analysis of total phenolics

The extraction of phenolic compounds was carried as described by Sun et al. [7]. Freeze-dried herb (0.1g) was extracted with 5 mL of methanol/water (60:40, v/v) using sonication for 60 min at 21°C. The sample was centrifuged at 1000g for 15 minutes and supernatant used for analysis. Total phenolic determination was carried as described by Singleton & Rossi [8].

Analysis of total carotenoids & chlorophyll

The carotenoids & chlorophyll were extracted as described by Giallourou et al. [9] with slight modifications. Methanol (4 ml) was added to 25 mg of powder and the samples were shaken for 15 min at 8000 rpm. Following centrifugation at 4000 rpm for 5 min, the supernatant was transferred to a clean tube and the process was repeated until a colourless supernatant was obtained. The absorbance of the combined supernatants was measured at 470, 645 and 662 nm. The total amount of carotenoids & chlorophyll was calculated according to the equations by Lichtenthaler & Buschmann [10].

Sensory analysis

Sensory evaluation was carried out using Quantitative Descriptive Analysis (QDA) on micro and mature coriander fresh leaves via a trained panel (n=11) on a gLMS scale [11,12].

Results and discussion

Microgreen coriander had significantly higher ($p<0.05$) levels of total phenols in comparison to mature plants (24.1mg GAE/g and 16.4 mg GAE/g (d.w.), respectively), however there was no significant difference in the content of total carotenoids (1.6 vs 1.6 mg/g d.w.) or chlorophylls (8.5 vs 8.3 mg/g d.w.) between MGC and MC.

In general, higher levels of amino acids (more than 2 fold) were found in the MGC compared to the mature counterpart (24.5 mg/g and 11.0 mg/g (d.w), respectively). Of sixteen amino acids identified, the predominant one was asparagine (15.82 vs 5.01 mg/g (d.w) in MGC and MC, respectively) followed by glutamine (1.99 vs 1.05 mg/g (d.w)), aspartic acid (1.75 vs 1.48 mg/g (d.w)) and glutamic acid (1.44 vs 1.09 mg/g (d.w)) although differences for these three amino acids were not significant. Free amino acids may contribute to the flavour quality of the herbs by their own taste characteristics including sweet, sour and bitter taste. Significant differences ($p<0.05$) were found in the levels of glycine and tryptophan, thus potentially contributing to the sweet and bitter taste of the MGC.

Thirty-six compounds were identified in the headspace of the coriander herbs and the significant ones are listed in Table 1. Terpenes were the major compounds identified in the MGC comprising 62% of the total volatile compounds collected from the headspace whereas aldehydes, particularly hexanal, together with alkanes and alkenes represented 87% of the total volatile compounds collected from the headspace of the MC. The most abundant compound present in the MGC was linalool (more than 30 fold higher in microgreen coriander compared to mature coriander). Previous research on the chemical profile of coriander essential oil has also indicated that it is a rich source of oxygenated monoterpenes, with linalool as the principal constituent [11]. Additionally, α-pinene, γ-terpinene, limonene and p-cymene were also detected as the main compounds in the MGC samples.

Table 1: Volatile compounds in the headspace of microgreen (MGC) and mature (MC) coriander.

	LRI[A]	*MGC*[B]	*MC*[B]	*P**
Methyl 2-methylbutanoate	777	238	113	*
Hexanal	799	804	1613	*
Methyl 2-methyl-2-butenoate	825	335	70	**
α-Pinene	940	4539	nd	***
Camphene	956	643	nd	**
cis-Sabinene	979	259	nd	**
β-Pinene	984	208	nd	**
β-Myrcene	994	676	nd	**
Linalool	1102	11636	370	***
Nonanal	1105	703	439	**
p-Cymene	1030	1587	nd	**
Limonene	1035	1727	550	**
(Z)-β-Ocimene	1050	136	nd	**
γ-Terpinene	1064	2374	nd	**
Terpinolene	1095	248	nd	**
Camphor	1158	774	18	***
Borneol	1178	414	1	**
Dodecane	1200	579	264	*

[A] Linear retention index on DB-5 column, calculated from a linear equation between each pair of straight chain alkanes C6–C20.
[B] Estimate quantities (ng) of compound in the headspace of 0.5g of herb calculated by comparison with 5000ng of propyl propanoate used as internal standard.
*Significant at the 5% level;
**Significant at the 1% level;
***Significant at 0.1% level. Means of three replicate samples; nd, not detected

Results from the sensory analysis are show in Figure 1. MGC was rated as more intense for both bitterness and sweetness which could be associated with significantly higher levels of phenolic compounds as well as bitter and sweet tasting amino acids in MGC (Figure 1A). However, no significant differences in umami were observed between the microgreen and mature coriander thus confirming the amino acid results where similar levels of aspartic acid and glutamic acid, responsible for umami taste, were found in both samples.

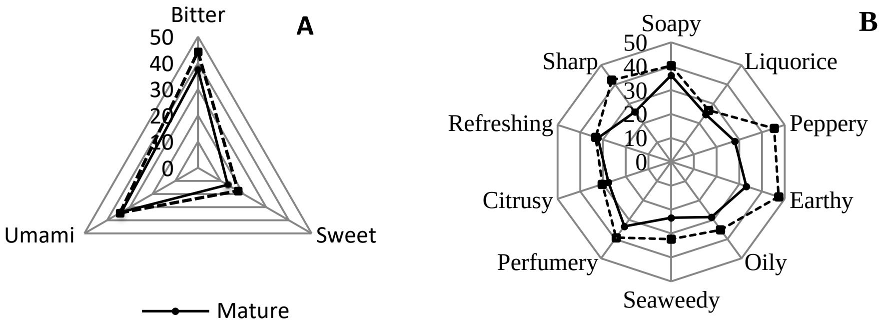

Figure 1: Radar plot and cobweb representing the taste (A) and flavour (B) profiles of microgreen (MGC) and mature (MC) coriander. Intensity of each attribute was marked on a gLMS scale (n=11) ($p< 0.05$).

Flavour characteristics (Figure 1B), on the other hand, showed significant differences between MGC and MC in the attributes “peppery”, “earthy” and “sharp”, commonly used to describe the flavour of coriander [12], on the gLMS scale with the MGC scoring higher than MC, which could be associated with higher levels of β-myrcene (peppery) and α-pinene (earthy). Furthermore, higher “perfumery” and “citrusy” notes were also associated with MGC. Linalool which was the major compound in the MGC generally contributes to the floral and pleasant notes. Several other terpenes such as limonene, γ-terpinene and terpinolene, present at higher level in MGC, could be responsible for the citrus notes described by the panellists.

Results of the current study suggest that microgreen coriander could potentially be used as novel culinary ingredients whose widespread popularity may be dependent on familiarization of consumers with their particular sensory attributes.

References

1. J.S. Lee, W.G. Pill, B.B. Cobb and M. Olszewski (2004) J. Hort. Sci. Biotech. 79:565–570.
2. E. Pinto, A.A. Almeida, A.A. Aguiar and I.M.P.L.V.O. Ferreira (2015) J. Food Compost. Anal. 37, 38-43.
3. Z. Xiao, G.E. Lester, Y. Luo and Q. Wang (2012) J. Agric. Food Chem. 60, 7644-7651.
4. Z. Xiao, G.E. Lester, E. Park, R.A. Saftner, Y. Luo, and Q. Wang (2015) Postharvest Bio. Tech. 110:140–148.
5. Morales-Soto, M.J. Oruna-Concha, J.S. Elmore, E. Barrajón-Catalán, V. Micol, C. Roldán, and A. Segura-Carretero (2015) Ind. Crops and Prod. 74, 425-433.
6. J.S. Elmore, G. Koutsidis, A.T. Dodson, D.S. Mottram, and B.L. Wedzicha (2005) J. Agric. Food Chem. 53, 4, 1286-1293
7. J. Sun, Z. Xiao, L. Lin, G.E. Lester, Q. Wang, J.M. Harnly, and P. Chen (2013). J. Agric. Food Chem. 61(46): 10960-10970.
8. V.L. Singleton, and J.A. Rossi (1965) J. Enol. Vitic. 16, 144-158
9. N. Giallourou, M.J. Oruna-Concha, and N. Harbourne (2016) Food Chem. 212 :411-419
10. H. K. Lichtenthaler, and C. Buschmann (2001). In CPFAC. John Wiley & Sons, Inc.
11. H.T. Lawless, and H. Heymann (2010) Springer Science & Business Media.
12. L.M. Bartoshuk, V.B. Duffy, B.G. Green, H.J. Hoffman, C.-W. Ko, L.A. Lucchina, L.E. Marks, D.J. Snyder, and J.M. Weiffenbach (2004) Physiol & Behav., 82, 109-114.
13. K. Msaada, K. Hosni, M.B. Taarit, T. Chahed, M.E. Kchouk, and B. Marzouk (2007) Food Chem. 102, 1131-1134.
14. L. Mauer, and A. El-Sohemy (2012) Flavour, 1, 1-5.