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Sensory profiling of honeybush tea (*Cyclopia* species) and the development of a honeybush sensory wheel

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ABSTRACT

Several *Cyclopia* species (*Cyclopia sessiliflora*, *Cyclopia longifolia*, *Cyclopia genistoides*, *Cyclopia intermedia*, *Cyclopia subternata* and *Cyclopia maculata*), used as honeybush herbal tea, were analyzed using descriptive sensory analysis in order to develop a generic honeybush sensory wheel. It was found that the "characteristic" sensory profile of honeybush could be described as "floral", "sweet-associated", "fruity", "plant-like" and "woody" with a sweet taste and a slightly astringent mouthfeel, whereas other attributes defined differences in the sensory characteristics between the *Cyclopia* species. The species could be divided into three distinct groups: group A (*C. sessiliflora*, *C. intermedia* and *C. genistoides*) associated with "fynbos-floral", "fynbos-sweet" and "plant-like" attributes, group B (*C. longifolia* and *C. subternata*) with "rose geranium" and "fruity-sweet" and group C (*C. maculata*) with "woody", "boiled syrup" and "cassia/cinnamon". The large sample set enabled the development of a generic honeybush sensory wheel, comprising of 30 attributes, organized into positive and negative attributes in primary and secondary tiers. Gas chromatographic-olfactometry of the aroma fraction of a sample of *C. maculata* with a prominent spicy aroma indicated a high level of eugenol, the only aroma-active compound that associated with a spicy aroma.

1. Introduction

Honeybush is a traditional South African herbal tea, produced from the leaves and stems of a number of *Cyclopia* species. Concerted effort since the 1990s to expand the honeybush industry included the development of international markets. The major importers are the Netherlands, Germany, United Kingdom and USA (Joubert, Joubert, Bester, De Beer, & De Lange, 2011). The primary commercial product is the "fermented" herbal tea, produced through a high temperature oxidation process. Processing conditions and equipment vary from processor to processor, resulting in a large variation of sensory quality and thus a loss of consumer confidence. Additionally, several *Cyclopia* species are used for herbal tea production, with the retail product usually consisting of a blend of *Cyclopia* species. The composition of the blend depends largely on production yield and availability and is not governed by the need to produce a consistent sensory profile. Blending different *Cyclopia* species, without taking into account their different sensory profiles, results in variable profiles and therefore also a likely loss of consumer confidence. Current production consists mainly of *Cyclopia intermedia*, *Cyclopia genistoides* and *Cyclopia subternata*. However, with demand exceeding supply an interest in other species (*Cyclopia sessiliflora*, *Cyclopia longifolia* and *Cyclopia maculata*) with commercial potential has developed, expanding the range of honeybush sensory profiles. While correct blending could improve product consistency, it could lead to a loss of the unique flavor associated with individual species. Unique sensory profiles could potentially be used to establish niche markets.

Previously, descriptive terms used to describe the flavor of honeybush tea were rather broad-based and included sensory descriptors such as "sweet" and "honey-like" (Du Toit & Joubert, 1998, 1999). Cronje (2010) also used broad-based sensory descriptors such as "characteristic honeybush" and "rose geranium-like" in an attempt to differentiate the major flavor differences between species. This lack of specific sensory terminology to describe the unique flavor profile of each *Cyclopia* species contributes to the present challenge of effective quality control and the development of products with specific flavor profiles for niche markets.

Following the recent development of a sensory wheel for another South African herbal tea, rooibos (Koch, Muller, Joubert, Van der Rijst, & Næs, 2012), the honeybush industry indicated the need for a similar quality control tool. Current regulatory control of the quality of honeybush makes no provision for aroma or flavor, except to stipulate that it should be "characteristic honeybush" without any clarification of this description (Anonymous, 2000). Therefore this study was conducted on six *Cyclopia* species to develop a "generic" honeybush

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sensory wheel, comprising the major positive and negative flavor, taste and mouthfeel attributes of this herbal tea. In addition, gas chromatographic-olfactometry (GC–O) of *C. maculata* with a very prominent spicy aroma was conducted to determine the major aroma-active compounds of this species, in particular to identify compound(s) contributing to a spicy note.

2. Materials and methods

2.1. Honeybush samples

A total of 58 honeybush samples, representing six *Cyclopia* species (*C. sessiliflora*, *C. longifolia*, *C. genistoides*, *C. intermedia*, *C. subternata* and *C. maculata*), were randomly sourced from commercial processors. In cases where limited or no production samples of a species were available, additional samples were prepared by laboratory-scale processing at the Post-Harvest & Wine Technology Division of ARC Infruitec–Nietvoorbij, Stellenbosch, South Africa. Plant material was randomly harvested to introduce normal compositional variation. The full sample set thus represented a range of sensory qualities, typical of commercial honeybush. The samples of *C. sessiliflora* and *C. longifolia* consisted of seven independent batches each, whereas those of the other species consisted of eleven independent batches each, with each batch representing a replicate.

For laboratory-scale processing different batches of plant material, comprising the shoots, were harvested at several locations in the Western Cape Province, South Africa during 2010 and 2011 and processed according to a standardized protocol as described by Le Roux, Cronje, Joubert, and Burger (2008). Briefly, the plant material, mechanically cut into small pieces, were moistened to ca. 65% moisture content and "fermented" at either 80 °C for 24 h or 90 °C for 16 h in temperature-controlled laboratory ovens. Following drying under controlled conditions (40 °C for 6 h) a sub-sample (200 g; <10% moisture content) was sieved for 30 s using a SMC Mini-sifter (JM Quality Services, Cape Town, South Africa) and the fraction <12 mesh and >40 mesh collected. The sieved plant material was stored in sealed glass jars at room temperature until analyzed.

2.2. Sample preparation

Freshly boiled distilled water (900 g) was poured onto 11.25 g sieved plant material, infused for 5 min and strained into a 1 L stainless steel thermos flask. The infusion (ca. 100 mL) was served in white porcelain mugs covered with plastic lids to prevent loss of volatiles. Measures taken to keep the temperature of the infusions constant during serving include pre-heating of the thermos flasks and mugs and the use of a temperature-controlled (65 °C) scientific water baths during serving as proposed by Koch et al. (2012).

2.3. Descriptive sensory analysis

Nine experienced assessors were selected to participate in this study. The sensory panel was trained according to the consensus method as described by Lawless and Heymann (2010). The basic protocol of Koch et al. (2012) was used to analyze all the samples during 24 training sessions where the panel generated aroma, flavor, taste and mouthfeel terminology. Four to six samples were analyzed per session. Aroma was defined as the aromatics perceived through orthonasal analysis, flavor as the retronasal perception and taste as the basic taste modalities. Mouthfeel was described as the tactile sensation that occurred in the oral cavity (Ross, 2009).

As for Koch et al. (2012), reference standards illustrating the respective major sensory attributes of the herbal infusions were introduced to the panel to clarify the meaning of each descriptor. For each session the panel also received one specific honeybush sample (*C. intermedia*), not part of the test samples, which served as a control sample throughout all sessions. This sample was selected to serve as a fixed point to which all other samples could be compared, thereby allowing panelists to calibrate their sensory perception at the start of each training and testing session.

A total of 68 aroma and 51 flavor, taste and mouthfeel descriptors were generated during the training period. By deliberating the relevance and redundancies of the descriptors, the list was reduced to 28 aroma, 23 flavor and 3 taste descriptors and 1 mouthfeel descriptor, totaling 55 descriptors (Table 1). The list of descriptors included positive, as well as negative sensory attributes, i.e. attributes associated with good and poor quality, respectively. A score sheet was then developed which was used by the panel to scale the intensity of each of the descriptors on a 100 mm unstructured line scale.

After completion of training the assessors scored the intensities of the selected attributes for all samples. Each sample was analyzed only once. Two sessions were conducted per day during which 8 to 12 samples were analyzed. Samples were labeled with blinding codes and presented in a randomized order. The fixed point control sample was labeled as such so that it could be identified by the assessors and used for comparison. All analyses were conducted in booths fitted with controlled lighting and the data captured, using Compusense *five*® (Compusense, Guelph, Canada).

2.4. Gas chromatography–olfactometry

Sample preparation and gas chromatography–olfactometry (GC–O) were carried out largely as described by Le Roux, Cronje, Burger, and Joubert (2012). An infusion of one sample of *C. maculata* (Mac 3), chosen for its prominent spicy aroma, was prepared by adding boiling distilled water (130 mL) to 20 g of the plant material in an insulated flask. The flask was sealed immediately and the plant material was infused for 15 min while swirling the contents of the flask periodically, followed by filtering. For each analysis, 50 mL of the filtrate was transferred to a

Table 1
Final aroma, flavor, taste and mouthfeel attributes used for descriptive analysis.

Aroma attributes	Descriptors	Flavor, taste and mouthfeel attributes	Descriptors
Floral	Fynbos-floral	*Floral*	Fynbos-floral
	Rose geranium		Rose geranium
	Rose/perfume		Rose/perfume
Fruity	Lemon	*Fruity*	Lemon
	Orange		Orange
	Cooked apple		Cooked apple
	Apricot jam		Apricot jam
	Cherry		Cherry
Plant-like	Plant-like	*Plant-like*	Plant-like
	Woody		Woody
	Rooibos		Rooibos
	Pine		Pine
Nutty	Walnut	*Nutty*	Walnut
	Coconut		Coconut
Spicy	Cassia/cinnamon	*Spicy*	Cassia/cinnamon
Negative	Dusty	*Negative*	Dusty
	Yeasty		Yeasty
	Medicinal		Medicinal
	Burnt caramel		Burnt caramel
	Rotting plant water		Rotting plant water
	Hay/dried grass		Hay/dried grass
	Green grass		Green grass
	Cooked vegetables		Cooked vegetables
Sweet-associated	Fruity-sweet	*Taste*	Sweet
	Boiled syrup		Sour
	Caramel		Bitter
	Honey		
	Fynbos-sweet	*Mouthfeel*	Astringent