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Sensory profile of rooibos originating from the Western and Northern Cape governed by production year and development of rooibos aroma wheel

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ABSTRACT

Aspalathus linearis is cultivated in the Western Cape and Northern Cape provinces of South Africa for the production of rooibos, a herbal tea with a global footprint. A total of 208 samples, spanning the two production areas, three production years and three quality grades, were collected to delineate the effect of production area and year on rooibos sensory properties, as well as to ensure large variation, required for revision of the rooibos sensory wheel. The samples were analysed using descriptive sensory analysis to provide comprehensive profiling of aroma, flavour, taste and mouthfeel attributes. The primary aroma characteristic profile of rooibos, previously described as "rooibos-woody", "fynbos-floral" and "honey" was confirmed. Other aroma attributes that were perceived frequently and at high intensity in the sample set were "fruity-sweet", "caramel" and "apricot". Although not occurring as commonly as those of the primary aroma profile of rooibos, these attributes, manifested in samples from both production areas, forming a secondary aroma profile. In the present study the "hay/dried grass" aroma note appeared in 99% of the rooibos samples at low intensities and could therefore be considered to be part of the "characteristic" aroma profile of rooibos. No clear differences between production areas were evident, but production years could be distinguished based on differences in perceived aroma attribute intensities. The aroma wheel is more user-friendly as it will provide users, at a glance, with the relative importance of attributes (as determined by intensity and occurrence frequency). This is achieved by varying slice width according to the relative mean attribute intensity and the use of accompanying bar graphs indicating relative occurrence frequency of attributes. This quality control and "communication" tool can be used by industry to aid in the grading and marketing of rooibos tea.

1. Introduction

Rooibos tea, the herbal tea made from *Aspalathus linearis* (Burm. F) Dahlg. (Fabaceae), has found wide consumer appeal with many new markets added to the traditional European export markets since the 1990s (Joubert and De Beer, 2011). Of the total quantity exported in 2015 (6560 tons), Germany (31%) remains the dominant export market, followed by the Netherlands (16%), Japan (15%), the United Kingdom (11%), and the United States of America (7%). In 2015 the remaining 20% were exported to vastly different markets, including countries such as Sri Lanka and India where black tea (*Camellia sinensis*) is the main product for domestic consumption (rooibos export data supplied by the South African Rooibos Council, 2016).

With the continued growth in the popularity of rooibos, the need to understand and to profile the aroma and flavour of rooibos has become essential to ensure effective quality control, exploit niche markets and support rooibos as a geographical indicator. Rooibos with different aroma profiles could open up the opportunity for niche marketing, especially on a global level. Koch et al. (2012), using descriptive sensory analysis (DSA) to define the sensory profile of rooibos, showed that the sensory attributes responsible for the "characteristic" rooibos profile were "honey", "rooibos-woody" and "fynbos-floral" notes coupled with a slightly sweet taste and astringent mouthfeel. In the latter study these and other sensory attributes, including positive and negative sensory

Abbreviations: DSA, descriptive sensory analysis; ANOVA, analysis of variance; PCA, principal component analysis.

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attributes, were captured in a sensory wheel and lexicon, forming the first step towards a generic quality control tool for the rooibos industry. The need for such a quality control tool was identified, primarily because the South African legislation regarding rooibos tea is not clear on the standards of quality, stating that "all rooibos should have the clean, characteristic taste and aroma of rooibos" (Anon., 2002). Not only is this description of rooibos aroma and taste vague, it would have no meaning to a tea broker or consumer not familiar with rooibos. A clear and definitive indication as to the exact profile of typical rooibos tea was therefore required. A sensory wheel is regarded as a valuable communication tool (Drake and Civille, 2002; Stolzenbach et al., 2011; Vázquez-Araújo et al., 2012), ensuring that all role players within the rooibos industry have the same level of understanding of what exactly constitutes the "characteristic taste and aroma of rooibos".

The characteristic sensory attributes identified by Koch et al. (2012) were found to be present in the majority, if not all of the rooibos samples tested during that time. These samples, sourced during the 2009 production year, originated from plant material, grown mostly in the Western Cape Province of South Africa. Anecdotal evidence suggests that rooibos quality depends on factors such as the presence of young growth, the age of the bush, the cultivation area and climatic conditions, in addition to processing conditions (Joubert, 1994). The overall quality of rooibos can therefore vary from year to year, as is observed in the varying number of production batches receiving a high-quality grading each year (J. Basson, Rooibos Ltd., Clanwilliam, South Africa, April 2012, personal communication). Rooibos produced in the Northern Cape is subjected to slightly lower minimum and maximum daily temperatures, on average, than rooibos produced in the Western Cape (information supplied by ARC Institute for Soil, Climate and Water, South Africa). Whether the difference in production area translates into differences in the sensory profile of rooibos is unknown. Recently, we demonstrated that production area had little effect on the phenolic and phenylpropenoic acid content of rooibos. However, production year was shown to have a significant effect (Joubert et al., 2016). To date no research has been done on the effect of production area and/or production year on the sensory profile rooibos. It is important to establish the effect of the latter as it could impact on the validity of quality control tools such as the rooibos sensory wheel.

The aim of this study was to determine whether production area and year have an effect on the overall sensory profile of rooibos tea. To achieve this aim samples were procured from the two production areas, i.e. Western Cape and Northern Cape, South Africa over three production years (2011–2013). Their sensory profiles were analysed, generating a large base-line data set that allowed us to develop a rooibos aroma wheel.

2. Materials and methods

2.1. Rooibos samples

A total of 208 unpasteurised, "fermented" rooibos samples consisting of grade A, B and C samples from individual production batches were sourced in 2011, 2012 and 2013 from both the Western and Northern Cape provinces of South Africa. Grade A represents samples with the prominent intensities of the characteristic rooibos sensory attributes and no perceptible taints. Grade B represents the quality of the bulk of the annual production, with the samples characterised as having an overall milder sensory profile, and in some instances, a low intensity of the "hay-like" aroma note. In grade C samples taints are usually more prominent. Other factors such as clarity and colour of the infusion, as well as colour of the plant material also impact on the final grade (Koch et al., 2012).

Each sample (400 g) was sieved for 1.5 min at 190 rpm to remove any dust (<40 mesh) or coarse material (>10 mesh), using a SMC mini-sifter (JM Quality Services, Cape Town, South Africa). The sieved samples were stored in sealed glass jars at room temperature during analysis; thereafter the samples were moved into cold storage (4 °C). Similar to the study of Koch et al. (2012) a reference sample, consisting of a blend of six B grade unpasteurised rooibos samples, was used during both the training and testing phases of sensory analysis. The same reference was used during 2011, 2012 and 2013 (stored at 0 °C). This allowed panellists to "calibrate" their sensory perception at the start of each training and testing session, thereby reducing panel drift as it served as a fixed point to which all other rooibos samples could be compared. This sample embodied rooibos with the perfect balance between positive and negative attributes, thus representing a "characteristic" cup of rooibos tea.

2.2. Preparation of infusions

The rooibos infusions were freshly-prepared in triplicate before serving as described by Koch et al. (2012). Approximately 100 mL of infusion was poured into each of the required number of white porcelain cups, pre-heated to 70 °C in an industrial convection oven. Each cup was covered with a plastic lid to prevent or limit loss of volatiles and placed in a water bath controlled at 65 °C for the duration of the analysis period.

2.3. Descriptive sensory analysis

2.3.1. Panel training

Panellists were chosen according to availability and experience in sensory analysis. The majority of the panellists took part in the previous

Table 1
Rooibos aroma lexicon used during training of sensory panel: attribute names and descriptions.

Classification	General attributes	Specific attributes	Description
Positive aroma attributes	Floral aroma	Fynbos-floral	The unique, somewhat sweet aromatics associated with fynbos[a] vegetation
	Woody aroma	Rooibos-woody	Aromatics associated with dry bushes, stems and twigs of the rooibos vegetation
	Fruity aromas	Apricot	Aromatics associated with apricot jam
		Apple	Sweet aromatics associated with cooked apples or apple pie
		Citrus	The sweet aroma associated with ripe oranges
	Sweet-associated aromas	Fruity-sweet	Aromatics associated with the sweet/sour smell of non-specific fruit
		Honey	Aromatics associated with the sweet fragrance of fynbos honey or *Alyssum* blossoms
		Caramel	Sweet aromatics characteristic of caramelised sugar
	Spicy aroma	Sweet spice	Aromatics associated with sweet spice
Negative aroma attributes (taints)	Vegetative taints	Hay/dried grass	Slightly sweet aromatics associated with dried grass or hay
		Green grass	Aromatics associated with freshly cut grass
		Rotting plant water	Aromatics associated with the rotting aroma of old flower water
		Seaweed	Aromatics associated with seaweed that has been lying in the sun
	General taints	Burnt caramel	Aromatics associated with burnt sugar or burnt caramel
		Medicinal/rubber	Aromatics associated with Band-Aid® or burnt rubber
		Dusty	Earthy aromatics associated with dust from a gravel road or ground
		Musty/mouldy	Mouldy aromatics associated with mildew, damp cellars or wet hessian

[a] Fynbos is natural shrubland vegetation occurring in the Western Cape, South Africa.