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Effect of harvest date on growth, production and quality of honeybush (*Cyclopia genistoides* and *C. subternata*)

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ABSTRACT

Cyclopia spp., used for production of honeybush herbal tea, is endemic to specific climatic zones in the Western and Eastern Cape of South Africa. Most of the plant material is harvested from wild plants in mountainous areas. Production and market development of this popular herbal tea is unsustainable without increased commercial production. Information on cultivation requirements, growth habit and production potential is essential to ensure a sustainable industry. The effect of harvest date on growth, production and tea quality was evaluated in non-irrigated commercial plantations of *Cyclopia genistoides* and *Cyclopia subternata*. *Cyclopia genistoides* bushes, harvested annually, did not recover the height of un-harvested bushes. Fastest *C. genistoides* bush regrowth and highest dry mass yield occurred after February harvests, with September harvests resulting in the highest sieve quality and mangiferin content (only the second annual harvest). For the "fermented" product, its hot water soluble solids (as indication of cup strength) and total polyphenol content, tended to increase with years of harvest. The mangiferin content of "unfermented" (green) *C. genistoides* plant material increased with years of harvest. *Cyclopia subternata* bushes harvested during August and September recovered the fastest in height. The August and May harvests delivered the highest fresh mass yield, while harvesting during August delivered significantly more of the finer processed tea (<1400 μm) and less of the coarse fraction (>2800 μm) than a September, February or May harvest. Annual harvesting is encouraged, but harvesting should not take place during flowering (August to September), because the flowers add very little to the final product yield. Based on 10,000 bushes/ha, an estimated annual production of 8.5 or 10.4 tons/ha of *C. genistoides* and *C. subternata* (fresh plant material), respectively, can be achieved.

1. Introduction

Cyclopia spp. are part of the Fynbos biome (Van Wyk et al., 1997) and endemic to the coastal regions. The natural habitat spans an area from Piketberg on the West Coast to Port Elizabeth on the East Coast, growing seldom further than 50 Km from the sea and especially on cooler damper southern slopes (Kies, 1951). One of the exceptions is "kustee" (*Cyclopia genistoides*) that occurs from the Western Coast to the Southern Coast (Mossel Bay) on flat sandy soils (Joubert, 2000). *Cyclopia subternata*, commonly known as "vleitee", is widely distributed along the coastal mountain ranges (Tsitsikama, Outeniqua and Langeberg) where it occurs on the southern slopes (Joubert et al., 2011).

Traditionally several *Cyclopia* spp., harvested from the veld, were used to produce honeybush tea, mainly for home consumption. Production of the conventional honeybush herbal tea includes a "fermentation" (high-temperature oxidation) step. A growing demand for this product, following a concerted effort to establish a formal honeybush industry in the late 1990s, initiated cultivation trails with *C. genistoides* and *C. subternata*, amongst other species (Joubert et al., 2011). These two species, originating from different natural habitats, have evolved different survival strategies which may affect harvesting techniques. *Cyclopia genistoides* re-sprouts from a thickened root producing new coppice shoots after a fire or harvesting. The shoots are therefore cut at ground level when harvested, stimulating the formation of new shoots from the thickened root. In the wild, *C. subternata*, a non-sprouter, must be allowed to seed at regular intervals so as to generate new plants. It should not be cut back completely to the ground as too severe pruning places the plant under stress, leading to dieback. However, if not harvested regularly it becomes very woody. Regular harvesting ensures that the shoots stay relatively thin and are thus more suitable for tea processing (Joubert and Joubert, 2012).

Harvesting was traditionally done during the flowering period as bushes were then visible in the wild, but increasing market demand and pressure on processors have led to harvesting during early to late summer (du Toit et al., 1998). Currently harvesting takes place

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throughout the year. Flowers add bulk to the fresh mass, but disintegrate during fermentation and drying, adding to the particle size fraction smaller than 40 mesh (420 μm), classified as "dust". Du Toit and Joubert (1998), investigating *Cyclopia intermedia*, *Cyclopia maculata*, and *C. subternata*, demonstrated that the presence of flowers improved the aroma and flavour of the hot water infusion, but that they were not essential for the characteristic sensory properties, contrary to popular belief. The presence of a large number of saturated and unsaturated volatile C5–C18 aldehydes present in the flowers of *C. genistoides* may even have a detrimental effect on the flavour of the tea (Joubert et al., 2011). The flavour and astringency of *C. subternata* herbal tea were shown not to be affected by the plant age or age of re-growth, but the sweet aroma was enhanced by plant material from older plants (3 years) or older re-growth (12 months) (unpublished data).

The objective of the present study was to evaluate the effect of an annual harvest during different months conducted over two years on plant re-growth and size classification of the conventional herbal tea product of *C. genistoides* and *C. subternata.* In addition, quality of the fermented *C. genistoides* herbal tea product was also assessed in terms of its hot water soluble solids and total polyphenol content. Mangiferin and hesperidin, the main bioactive representatives of the xanthone and flavanone phenolic sub-classes present in *C. genistoides*, were quantified in the unfermented plant material to provide greater insight into the effect of harvest on quality indicators of the plant material.

2. Material and methods

2.1. Plant material

Non-irrigated mature commercial blocks of *C. genistoides* seedlings in the Reins, Albertinia area of the Western Cape (34° 17′ S, 21° 32′ E) and *C. subternata* seedlings (3-year-old plants) in the Kanetberg, Riversdale area of the Western Cape (34° 06′ S, 21° 15′ E), were harvested. Total annual rainfall varied between 330 and 600 mm, falling mostly between April and August. Long-term average maximum and minimum winter and summer temperatures were between 17.8 °C and 6.3 °C and between 28.6 °C and 16.9 °C, respectively (Agrometeorology Databank, Institute for Soil, Climate and Water (ISCW), Agricultural Research Council (ARC)).

2.2. Treatments

Treatments consisted of the annual removal of all harvestable material from treatment bushes beginning either during August, September, February or May, for three consecutive harvests. *Cyclopia genistoides*, a re-sprouter, was cut back to soil level, while *C. subternata*, a re-seeder, was cut back to just above the previous harvest level (ca. 30 cm above soil level), allowing sufficient remaining leaf area for re-growth. Fig. 1 provides a schematic outline of the treatment time-lines indicating harvest points. Treatments were replicated five times randomly within rows using a randomized block design with each replication having between nine and 16 bushes, the final number depending on the survival rate during the study.

Data were gathered for both species during the growing season to provide quantitative growth trends (i.e. bush height), as well as bush height and fresh mass at each harvest. The harvested plant material was processed and used to determine the dry mass and particle size distribution of the herbal tea product. In the case of *C. genistoides* the latter plant material was also used for the determination of quality parameters, i.e. the hot water soluble solids and total polyphenol content. The mangiferin and hesperidin content of the unfermented plant material was also determined for *C. genistoides*. Control treatments were not harvested or sampled for quantitative measurements, but only used for monitoring growth trends. The control treatment of *C. subternata*, but not *C. genistoides*, was cut back at the start during August.

Approximately once every two months after the start, and at the end of the study, bush height of all treatments and the control was measured using a calibrated staff. At each harvest time, all harvestable material was removed and mechanically shredded with a fodder cutter with adjustable feed speed to limit cut length to 3 mm. The shredded material was mixed to improve homogeneity of a sample, sub-divided, and then either dried to obtain unfermented plant material, or fermented and dried to obtain fermented plant material (as described in Le Roux et al., 2008). Fresh mass (kg/bush) prior to processing and dry mass (kg/bush) of the fermented sub-samples were recorded at the end of the study.

2.3. Analyses

Particle size distribution of a sub-sample of dried, fermented material was determined using 45, 850, 1000, 1400, 1700 and 2800 μm size sieves. Six size ranges consisting of 45–850 μm, 850–1000 μm, 1000–1400 μm, 1400–1700 μm, 1700–2800 μm and >2800 μm were used to differentiate between treatments.

A representative sample of fermented *C. genistoides* material from each treatment and replication was finely milled using a Retsch rotary mill and 1 mm sieve. An aliquot (2 g) was extracted for 2 min with

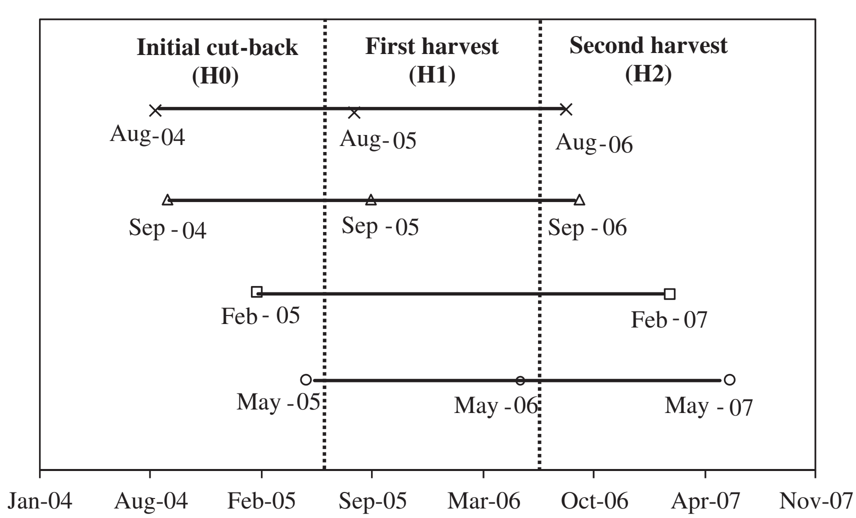

Fig. 1. Schematic outline of harvest treatment time-lines for *Cyclopia subternata* and *Cyclopia genistoides*. Markers represent harvest times with the first marker for each treatment representing the initial cut-back of bushes.