

Rooibos Tea

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Summary

Rooibos tea (*Aspalathus linearis* R. Dahlgr., Fabaceae), originating in South Africa, has in recent years become an increasingly popular health drink in Europe. In contrast to black or green tea (*Camellia sinensis* L.) rooibos contains no caffeine and comparatively little tannin. Therefore this tea may be consumed by children without causing any discomfort or problems. Recent studies have shown rooibos tea to contain anti-mutagenic, anti-carcinogenic, anti-inflammatory and anti-viral properties. The indicated health properties are attributed mainly to the anti-oxidative properties of the flavonols contained in the plant tissue. Of these, Aspalathin has until now only been found in rooibos tea. To facilitate rapid characterization of these value adding components a new HPLC-Procedure was developed. An innovative NIR-spectroscopic procedure makes possible the determination of the Aspalathin content in unfermented rooibos leaves; further, the fermentation process may be efficiently followed by using these non-destructive analytical techniques.

Rooibos Tea

Constituents,
characteristic effects
and analysis

These days Rooibos Tea is popular as a healthy beverage to be consumed instead of coffee, black or green tea. Because of its high mineral content it is also suitable as an isotonic sports drink. Its health promoting quality derives mainly from the constituent flavonols, contained primarily in the unfermented drug. Rooibos Tea is used in the treatment of food allergies, to enhance well being, to treat diverse skin diseases and, because of its anti oxidative properties, to support the immune system.

By Hartwig Schulz,
Boris Steuer and
Wofgang Schütze,
Quedlinburg

Historical Developments

The first reference to Rooibos Tea as a drink are found in the notes of the botanist Carl Peter Thunberg in 1772[1], recorded during an extended research trip to Africa and Asia. According to his notes, Rooibos (*Apalathus linearis* R. DAHLGR.), a member of the Fabaceen Family (Papilionacious plants), marketed in Germany under the name "Rooibos" or "Massai Tea", was already then consumed by the black population of South Africa.

A further spread of the use of the tea only occurred at the binning of the 20. Century after a Russian immigrant , Benjamin Ginsberg, the son of an old tea trader family started marketing the tea, initially in South Africa and later on in Europe. After a few short years the demand had risen to the extent that collection of wild Rooibos no longer sufficed, and it was therefore started to develop cultivation methods so as to farm Rooibos. Quite rapidly a numerous Rooibos Plantations were developed around Clanwilliam, a small town on the South African West Coast, and quantity of tea produced increased substantially in the fifties. As a result of lack of demand and overcapacity, the price of Rooibos Tea collapsed and a number of smaller farmers had to leave the industry. Since the the "Rooibos-Tea-Control-Board" regulates the production quotas, as well as ensuring that an unvarying high quality is maintained so as not to endanger the good export opportunities of the tea.

Cultivation

Most of the Rooibos Plantations (>75%) are in the Clanwilliam District; a smaller quantity of Tea is produced in the regions around Vanrhynsdorp and Calvinia. In total 570 tons of Rooibos Tea were harvested in 1996 in South Africa.

The seedlings required to stock a plantation are nurtured in acid, sandy soil with good drainage, whereafter the approximately 13 to 18 cm high young plants are transplanted to a density of approximately 800 plants per ha (Fig. 1 and 2). After eight months the bushes are pruned back to a height of 30 to 45cm so as to increase the degree of branching.

Rooibos Tea prefers a mild Mediterranean climate. While older Rooibos plants are usually apdted to cold winters and hot, dry summers, the young plants display some sensitivity to frost.

From the second year the Rooibos plants are harvested from all sides; partly the harvest is also conducted with machines, where these can usually only do a horizontal cut and so achieve a lower yield. During the manual harvest care is taken to avoid flowers finding their way into the tea, as this results in

Fig. 1: Rooibos Plantation near Graafwater (South Africa)

Fig. 2: Spring shoots on a Rooibos plant after harvesting.

a false aroma during the subsequent fermentation. The average age of a Rooibos plantation is eight years. The highest yields of approx. 250g dried extract per plant are obtained during the fourth and fifth year after planting [2]. However, even after the fourth year the plantations suffer losses as a result of fungal infection (Infection through *Diaporthe phaseolorum*) [3]. The infected plants may be recognized by the reddish brown discolouration as well as by the deformed shoot tips readily apparent in the planting. (Fig. 3)

Fig. 3: Fungal Infection by *Diaporthe phaseolorum* in an older Rooibos plant.

Of the four naturally occurring different Rooibos types only the genotype "Nortier" is used for commercial farming; in contrast the morphologically very similar type "Cedarberg" is only found in the wild in the region around Clanwilliam.

Harvest and Processing

The harvest generally commences in September or October. The approximately 40 to 50 cm long shoot tips from the Rooibos plants are bundled and transported to factories for further processing to processing plants specializing in the fermentation process. There the harvested twigs are cut as uniformly as possible into particles of 0,5 cm length, spread evenly on a stone floor and exposed to the sun for several hours, until the plant-particles have turned a reddish-yellow colour (Fig. 4.)

Fig. 4: Fermentation of freshly harvested Rooibos tea in a processing plant near Clanwilliam.

To initiate the enzymatic processes these are then mixed with water and, dependent on the weather, are then fermented for 8 to 24 hours. Afterwards the fermented tea is sun dried till a water content of less than 10 % is achieved. As a first quality check the fermented raw tea is tested as to purity, cut length, aroma, colouring as well as residual moisture. In a subsequent processing step the tea is sieved (customarily sieves with an aperture of 3mm are used), separating fine tea particles and minerals (so called dust) and finally pasteurized by means of hot steam (Fig.

Fig. 5: Sieving of the raw fermented Rooibos Tea.

5.). During the fermentation volatile aromatics, such as β -Ionon, β -Damascenon and 5,6-Epoxy- β -ionon, are formed in the tea, which contribute significantly to the sweet honey like flavour, as they similarly do in Ceylon tea. In addition several alcohols, aldehydes, ketones, and lactates contribute to the aromatic quality of the tea. In excess of 120 aromatically relevant components have been identified in Rooibos extracts using gas chromatographic mass spectrometry (GC-MS) [4].

The aroma profile and together with this the quality of taste is dependent within narrow tolerances on the processing methodology and the subsequent drying process. If the fermentation takes place below 40 °C a relatively high green tea fraction, precipitated by the aromatics Z- and E-3-Hexenal, is perceptible, and the spicy aspects introduced in particular by Phenylacetaldehyde are largely absent [5].

Fig. 6: HPLC-separation of value adding flavonols in unfermented (red) and fermented (blue) Rooibos Tea.
 Chromatography Column: 3,5 μ Zorbax SB Reversed Phase C-18 (3,0 x15mm; thermostatically controlled at 35 °C).
 Eluent: 1% aqueous Folic Acid/Acetonitrile (gradient elution). Detection:288nm.

Value Adding Constituents

Because of its comparatively high mineral content Rooibos Tea has been used for some time as a sportsman's drink. Analogously to the isotonic beverages its use results in a compensation of mineral imbalances (especially Sodium and Potassium) in the body. As Rooibos Tea has a natural sweetness it is generally not necessary to add sugar. The health promoting properties are mainly ascribed to the numerous flavonols as eg. Aspalatin, Nothofagin, Luteolin, Orientin, Quercetin, Quercitrin, Isoquercitrin, Rutin and Vitexin [6]. While most of these anti-oxidants occur ubiquitously in plants, Aspalathin has so far only been identified in Rooibos [7]. In contrast to this Nothofagin was identified more than 30 years ago in the heartwood of the Southern Beech (*Nothofagus fusca* L.) [8].

As may be seen in the HPLC-fractionation represented in Figure 6, there are considerable losses of Aspalathin and Nothofagin during the fermentation process [10]. While the unfermented tea has a Aspalathin content between 3 and 12 gm/100g, this is reduced drastically during processing to approximately 0,2 to 1,3 gm/100gm. It could be shown that the major portion of the Aspalathin was oxidized to flavonols as well as to as yet unknow polymer compounds. Similarly Nothofagin, found in the unfermented tea at levels of about 0,1 to 1,2 gm/100gm, could only be measured at levels around 0,01 to 0,3 gm/100gm after fermentation; the content of the flavonols found in the Rooibos leaves however remains almost unchanged.

Tabel 1: Aspalathin and Nothofagin content (gm/100gm) of various Rooibos Genotypes with cultivation region and technological processing.

Sample Identification	Processing	Aspalathin	Nothofagin
Clanwilliam, Zeekoeivlei	unfermented	7,27	0,91
Nardouwsberg, Vaalkrans	unfermented	8,03	0,52
Gifberg, Nuwedam	unfermented	5,87	0,60
Citrusdal, Berg-en-dal	unfermented	8,73	0,58
Leaves collected near Citrusdal	unfermented	11,9	1,33
Leaves with fungal infection	unfermented	4,45	0,68
Clanwilliam, Zeekoeivlei	fermented, sun dried	0,21	0,12
Clanwilliam, Zeekoeivlei	fermented, tunnel dried	0,16	0,11
Clanwilliam, Zeekoeivlei	fermented, unsieved	0,35	0,02
Citrusdal	semi-fermented	2,98	0,71
Clanwilliam, Zeekoeivlei	Dust	0,88	0,04
Choice Grade	fermented	0,14	0,10
Super Grade	fermented	0,21	0,12

In Tabel 1 the unfermented and fermented Aspalathin and Nothofagin content (as determined by HPLC) is given for selected samples of Rooibos. These results show a considerable variation of the two value adding flavonols with Genotype, cultivation region as well as harvest period.

Analysis of the Flavonols

After the first information of the presence of flavonols in Rooibos Tea became available, the identification of these compounds was initially done by thin film chromatography. Later a HPLC method was developed, used mainly to quantify Aspalathin and Nothofagin during the fermentation process [9]. The authors eventually further improved the HPLC separation efficiency to the point that today it is possible to separate the bulk of the valuable flavonols in 30 minutes and characterize these by means of UV-Vis-Detection.

To achieve a sufficient measure of reproducibility in the analytical results when doing serial determinations, it is necessary to stabilize the aqueous Rooibos samples with Ascorbic acid, as otherwise a definite decomposition of the two dihydrochalcones is encountered.

The composition changes occurring during the processing of the Tea discussed above may be clearly illustrated with the aid of Near Infrared Spectroscopy (NIRS). Although the NIR-spectra of the individual Rooibos Samples do not show any significant differences at first glance, it becomes possible to identify clearly separate grouping factors for fermented and unfermented Tea within the framework of a calibration model when employing main component and differential analysis. As expected semi fermented Tea samples are to be found between the clusters. Similarly the "Dust" fraction separated on further processing as well as that fraction separated from the main product prior to fermentation because of fungal infection may be clearly identified with the aid of NIRS (Fig.7).

Fig. 7: Differentiating between unfermented (blue) and fermented (red) Tea samples using major component analysis based on NIR spectroscopic data. Those samples not fermented because of quality shortfall (fungal infection) are marked in green.

To determine the Aspalathin content in unfermented Rooibos leaves a practical NIRS calibration model was developed. With an average experimental error of 0,65gm/100gm (Standard error of the cross validation) and a coefficient of correlation (R^2) of 0,76 a good correlation was obtained between the NIRS prediction and the HPLC reference data based on the 119 measured calibration samples (Fig. 8).

Fig. 8: NIRS calibration for Aspathalinin unfermented Rooibos Tea.

Determination of the Aspalathin Content

It is not possible to determine the Aspalathin content of fermented Rooibos samples using NIRS (No. of reference samples: 102, $R^2 = 0,33$); here the intensity of the analytical key frequency is obviously insufficient to resolve the data necessary to define the components.

The described NIRS methodology would appear to be well suited to determine reliable parameters for breeding (selection), cultivation, fermentation as well as prediction of the optimal harvest time. It is probable that in future increasingly Diode-Array-NIR-Systems will be used for these purposes, as with the aid of this type of spectrometer the requisite quality assays may be

done directly in the field, while the purchase price of these spectrometers are significantly lower than alternative NIR apparatus currently commercially available.

Therapeutic Applications

Since the early 70's a number of case studies showed that Rooibos Tea could be used to favourably influence food allergies in children.

Today it is accepted that these positive effects are brought about as a result of the flavonols contained in the Tea. In particular, Quercitin is known to inhibit the release of histamines in allergy sufferers, and so to alleviate the allergy symptoms considerably. [11]

Rooibos Salves

In connection with the described anti inflammatory effect Rooibos salves are used in South Africa especially in the baby cosmetic field (Fig. 9). In some cases of long term use a desensitizing effect with respect to the allergen was observed. For adults there are body lotions with Rooibos extracts on offer, which are said to offer increased protection against free radicals after sunbathing, and are claimed to alleviate mild sunburn (slight reddening of the skin) rapidly.

In addition Quercitin can inhibit the production of the enzyme Mono-amino-oxidase (MAO) in the human body, this in turn leading to greater quantities of the neural messenger Serotonin being produced. Overall this increased level of Serotonin results in a general feeling of well-being in many people, and, similarly as in the application of St. John's Wort preparations, mild depressions and sleep disorders are positively influenced by the consumption of Rooibos-Tea.

Fig. 9: Rooibos – Cosmetic Products from South Africa (Firma. Annique)

Antioxidative Effect

Aspalathin, a flavonol, is by contrast characterized by its ability to reduce the free oxygen radicals in the body. Analogously to the known radical scavenger enzyme Superoxiddismutase (SOD), Aspalathin is capable of metabolizing aggressive radicals into hydrogen peroxide, which in turn is metabolized to innocuous substances in human tissue by other enzymes. A recently published study concluded that the anti oxidative property of unfermented Rooibos is comparable to that of green tea [12]. The anti oxidative potential of fermented Rooibos Tea is however considerably lower due to the reduced Aspalathin content. In addition it is held that Aspalathin exhibits additional positive effects supporting the immune system which have to date not been scientifically studied in detail [13].

External Use for Skin Disorders

Similarly as with green tea the antioxidatively active flavonols speed up the healing process for various skin disorders such as excemas, photosensitivity, nappy rash, nettle-rash, and sunburn [14]. It has been reported that the application of Rooibos in the treatment of Behçet's disease, a chronic disease of the oral and genital mucous membranes, which in severe cases may result in blindness, resulted in the symptoms being alleviated.

For external application compresses of cold Rooibos tea (four table spoons Rooibos extract per liter water) are recommended on affected skin areas. For patients with nettle-rash a daily ration of 1,5 liters of Rooibos Tea with meals speeds up healing. Albeit that the anti allergenic properties of Rooibos Tea are still the subject of controversial debate, and despite studies being available which claim no effect with allergic skin reaction of type I [15], it is plain that Rooibos Tea is being employed successfully for many years in South Africa, eg. In the treatment of allergic colic in children. In the treatment of the so-called "Three-Month-Colic" good results are obviously achieved, which may be attributed to the specific flavonol profile of the tea plant. A further advantage is that babies and small children are quite happy to drink the tea because of its natural sweetness and its pleasant aroma, in contrast to indigenous medicinal teas such as aniseed, cumin or fenchal. Initial results of current research indicate that the polysaccharides fraction extract prepared from Rooibos leaves with sodium carbonate solution has a strong Anti HIV property in laboratory experiments. The currently conducted in vivo studies will show whether such Rooibos extracts may be successfully employed in Aids therapy in the future, and whether they may even replace some of the current pharmaceutical retro viral drugs, which do have considerable side effects [16]. In the use of Rooibos extracts as additives to foodstuffs or cosmetics, it is probable the processing of unfermented Rooibos leaves will become more important in the future, as beneficial components are still present in significantly higher concentration.