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3045 words (including subheaders)
First North American Serial Rights

last revision: 11/29/02

Rooibos Tea:
New Research Documents Antioxidant and Anticancer Properties

By Laurie Erickson

Antioxidants are hot topics in the health news these days, and now another tea is being marketed for its high antioxidant content as well as for its mild, sweet taste. Rooibos, pronounced ROY-boss, is a South African herb used to make a tea that is naturally caffeine-free, low in tannin, and rich in polyphenol antioxidants. Although the tea is new to the American market, it has been made in the Cedarberg mountain region of South Africa for generations. Recent studies have shown that some of the antioxidants found in rooibos tea may protect against cancer, heart disease, and stroke. Distributors are promoting the tea for all kinds of health benefits. What's the evidence for these claims?

Historical Background

Rooibos (*Aspalathus linearis* (Burman f.) Dahlgren, Fabaceae) is a shrubby legume that is indigenous to the mountains of the Cape Province in South Africa. Rooibos grows in coarse, low-acid soil in areas where summers are hot and dry. The plant reaches 1½ to 5 feet in height and produces yellow flowers in the spring. When cultivated

commercially, the needle-like leaves and stems are usually harvested once a year in the summer.

Local inhabitants of the mountainous regions of the Cape Province were the first to collect wild rooibos and use it to make tea. Rooibos became a cultivated crop in the late 1920's, and it has been grown commercially since World War II.[1] Rooibos is now exported to countries worldwide, including Germany, Japan, the Netherlands, England, Malaysia, South Korea, Poland, China, and the United States.[2] The total domestic and international sales of rooibos in 1999 amounted to 6150 tons, of which 1800 tons were exported to 31 countries.[2] The small towns of Clanwilliam and Wuppertal north of Cape Town in the Cedarberg region have a long history of rooibos cultivation; these towns are popular tourist stops because of their beautiful rural scenery and their role in the rooibos industry.

As international demand for rooibos has increased, small farmers in South Africa have had difficulty competing with larger producers of rooibos. Since 1999, the nonprofit organization Agribusiness In Sustainable Natural African Plant Products (ASNAPP) has helped small farmers in and around Wuppertal to implement methods of rooibos cultivation that allow them to compete successfully in the world market. ASNAPP has encouraged farmers to grow rooibos organically because organic rooibos sells for a higher price. ASNAPP has also helped improve the infrastructure needed to bring rooibos to the marketplace and has provided contacts between small farmers and buyers. ASNAPP is sponsored by the United States Agency for International Development (USAID), the Herb Research Foundation (HRF), Rutgers University, and Stellenbosch University.

Rooibos Tea Comes In Two Forms: Fermented and Unfermented

In the strict sense, the word *tea* is reserved for infusions made from the leaves of the *Camellia sinensis* plant (white, green, oolong, and black tea). Infusions made from herbs such as rooibos are more accurately called *tisanes*; however, the word tea is commonly used for herbal infusions, and this relaxed usage is followed here.

Rooibos is processed two different ways, producing two types of tea. The green leaves and stems are picked and then either bruised and fermented or immediately dried to prevent oxidation. The traditional fermented type is called red tea because fermentation turns the leaves and the resulting tea a rich orange/red color; this distinctive color led to the African name *rooibos*, which means "red bush." The newer unfermented type, often called green rooibos, contains even higher levels of polyphenol antioxidants (some antioxidants are lost in the fermentation process).

Both types of rooibos tea are available plain or flavored, loose or in tea bags, organic or conventionally grown. Rooibos is graded according to color, flavor, and cut length, with the highest grade labeled "supergrade." The tea has a smooth, non-bitter flavor that is good hot or chilled. The unfermented type has a mild "green" taste reminiscent of green tea but without the astringency; the fermented type is very different, with a stronger sweet and fruity taste. Many commercially available flavored varieties of rooibos are not organic; however, unflavored organic rooibos can easily be flavored by adding some fruit juice or organic herbs and spices.

Antioxidants in Rooibos

Free radicals (unstable molecules that have lost an electron) can damage the DNA in cells, leading to cancer, and they can oxidize cholesterol, leading to clogged blood vessels, heart attack, and stroke. Antioxidants can bind to free radicals before the free radicals cause harm. One group of antioxidants is called *polyphenol* because these substances contain a phenolic ring in their chemical structure. The polyphenol group is further divided into subgroups such as the *flavonoids*, and the flavonoid group can be broken down into yet more subgroups. Rooibos tea contains many polyphenol antioxidants that seem to be potent free radical scavengers in laboratory studies.

The polyphenol antioxidants identified in rooibos tea include the flavonoids aspalathin, nothofagin, quercetin, rutin, isoquercitrin, orientin, isoorientin, luteolin, vitexin, isovitexin, and chrysoeriol. A recently published analysis of fermented rooibos measured the levels of all the flavonoids listed above except nothofagin (see Table 1).[3] Of the 10 flavonoids measured, the three that occurred in largest amounts were aspalathin, rutin, and orientin, followed by isoorientin and isoquercitrin. Nothofagin was identified by mass spectrometry but was not quantified because a standard was not available for it. Aspalathin and nothofagin are present in relatively large amounts in unfermented rooibos tea, but some of the aspalathin and nothofagin oxidizes to other substances during fermentation; thus, fermented rooibos contains less aspalathin and nothofagin than unfermented rooibos.[4] The amount of nothofagin in fermented rooibos was estimated to be about three times less than aspalathin in one study.[4]

Rooibos tea does not contain epigallocathechin gallate (EGCG), which is the substance in green tea that has shown anticancer and antioxidant capabilities. Despite

claims in some promotional material, an average cup of rooibos tea has less total polyphenols than an average cup of green or black tea. Elizabeth Joubert, PhD, specialist researcher at South Africa's ARC Infruitec-Nietvoorbij and a rooibos expert, says that the total polyphenol content of a cup of rooibos can be as much as 60 to 80 mg, depending on the brewing time and amount of leaves used.[5] The types of polyphenols in rooibos tea are different than those in green and black teas, so the potential health benefits of the teas can't be compared solely on their total polyphenol content.

Quercetin and Luteolin: Two of the polyphenols in rooibos tea, quercetin and luteolin, are potent antioxidants found in many fruits and vegetables. Studies in the test tube (in vitro) have shown that these antioxidants can cause pancreatic cancer cells to "commit suicide," referred to as apoptosis.[6,7] In vitro studies have found various methods by which quercetin and luteolin can cause apoptosis.[6,7,8,9] In addition to causing death of cancer cells, quercetin decreased primary tumor growth and prevented metastasis in a model of pancreatic cancer.[7] Luteolin inhibited proliferation of thyroid cancer cells in vitro,[10] and quercetin inhibited proliferation of colon cancer cells in vitro.[11] Quercetin inhibited cyclooxygenase-2 (COX-2) expression in colon cancer cells; inhibition of COX-2 enzyme activity has been linked to prevention of colon cancer.[12,13] Both luteolin and quercetin can block the formation of lipid peroxides.[14,15,16] A single oral dose of luteolin given to mice 2 hours prior to exposure to irradiation reduced lipid peroxidation in the bone marrow and spleen.[16] The question is whether enough of these two antioxidants are present in rooibos tea and absorbed by the body to have beneficial effects. As shown in Table 1, recent analysis of fermented rooibos found considerably

more quercetin than luteolin,[3] but even quercetin was present in much lower amounts than aspalathin, orientin, and rutin.

Aspalathin and Nothofagin: A unique polyphenol that is one of the most abundant in rooibos tea, aspalathin, seems to contribute to the antioxidant capabilities of rooibos, but aspalathin is not as well studied as quercetin and luteolin. Nothofagin is similar in structure to aspalathin. Joubert says that her research group just recently developed a way to isolate pure aspalathin from rooibos. She says, "According to unpublished in vitro studies done at ARC Infruitec-Nietvoorbij, aspalathin compared well with quercetin in terms of antioxidant activity, except in a fat medium where quercetin demonstrated much higher potency than aspalathin. What is important in these comparative studies is the test environment. Relative efficacy will depend on the test system used (the polarity of the medium, the type of free radical that needs to be scavenged, etc)." [5]

Orientin and Rutin: Orientin and rutin are two of the other most abundant antioxidants in rooibos, and both have been associated with health benefits. Orientin is a potent free radical scavenger. It reduced by half the number of cancer-associated changes in cells of human blood exposed to radiation.[17] When mice were exposed to radiation, orientin protected against lipid peroxidation in the liver and also reduced damage to the bone marrow and gastrointestinal tract.[18,19] Rutin, a bioflavonoid found in buckwheat and some fruits and vegetables, seems to help maintain the strength of capillary walls; oral rutin as well as oral and topical o-(beta-Hydroxylethyl)-rutoside (HR) have been used to treat hemorrhoids, varicose veins, and the lower leg edema associated with venous insufficiency and venous hypertension. [20,21,22,23,24,25]

The studies referenced above show that rooibos tea contains antioxidants that have positive effects when tested as isolated substances. So, do all these antioxidants in rooibos tea lead to health benefits for tea drinkers?

Research on Rooibos

Laboratory studies have demonstrated beneficial effects of rooibos in the test tube (in vitro) and in live animals (in vivo), but human studies have not been conducted. Much more research is needed, but the studies so far look intriguing.

Researchers found that fermented rooibos tea reduced cancer-associated changes in animal cells induced by the mutagens benzo[a]pyrene (B(a)P) and mitomycin C (MMC) both in vitro and in vivo.[26] The in vitro part of the study measured chromosomal aberrations in animal cells caused by exposure to the mutagens. The cells were treated with tea extract either at the same time as the mutagen or after the mutagen. Some of the tests used rat liver microsomal enzyme, called S9, to provide metabolic activation of the mutagen, and some tests omitted S9. Both green tea and rooibos tea suppressed aberrant cells caused by B(a)P and MMC in the presence of S9, but rooibos showed a greater suppression of aberrant cells than did green tea. In fact, when the cells were exposed to B(a)P and S9 simultaneously with rooibos tea, the highest concentration of rooibos tea completely inhibited the aberrant cells, bringing their percentage down to the level of the controls that were not exposed to any mutagen. Also, rooibos tea suppressed aberrant cells caused by MMC both with and without the presence of S9, but green tea showed no suppression without S9.

In the in vivo part of this study, mice were given oral doses of tea and an injection of B(a)P or MMC.[26] The researchers measured the frequency of micronucleated reticulocytes (MNRETs), which are cells with damaged DNA that may lead to cancer. For example, when a single dose of tea was given 6 hours prior to an injection of MMC and the number of MNRETs was counted 48 hours after the MMC, rooibos tea and green tea provided similar inhibition of the frequency of MNRETs. When the mice received the mutagen prior to the tea or 24 hours after the tea, neither green tea nor rooibos tea reduced the frequency of MNRETs. When the teas were given daily for 28 days and then the mutagen was injected on day 29, rooibos tea and green tea reduced the frequency of MNRETs caused by B(a)P, and rooibos tea in the highest test concentration also reduced MNRETs caused by MMC.

Another research group showed that fermented rooibos tea extract reduced cancerous transformation of mouse cells exposed to x-rays in vitro.[27] The amount of protection correlated with the dose of rooibos. Interestingly, green tea in equivalent concentrations did not show any protective effect. In another study, fermented rooibos tea reduced cell damage in live mice that were exposed to irradiation two hours following a single dose of rooibos administered by gastric intubation.[16]

Rats given fermented rooibos tea daily ad libitum (free access) from the age of 3 months to 24 months had greatly reduced age-related lipid peroxide accumulation in their brains compared to rats that drank plain water.[28] The lipid peroxide levels were evaluated by measuring the amounts of thiobarbituric acid reactive substances (TBARS) in eight regions of the brain. The study's authors write, "The contents of TBARS in the frontal cortex, occipital cortex, hippocampus and cerebellum of the aged group without rooibos

tea were found to significantly increase compared to those of the 5-week-old group. On the other hand, the contents of TBARS in these regions in the aged group with rooibos tea were lower than those in the aged group without rooibos tea, and were quite similar to those in the young group. These results suggest that the administration of rooibos tea protected several regions of the rat brain against lipid peroxidation accompanying aging." Magnetic resonance images taken of the brain were consistent with the TBARS data. Age-related increases in lipid peroxides in the brain may damage neuronal cells and cause diseases such as stroke.

Another study found that both fermented and unfermented rooibos tea exhibits anticancer properties in vitro as measured by the Salmonella typhimurium mutagenicity assay with several different mutagens.[29] Further research showed that the fermentation process causes a decrease in the anticancer and antioxidant activity of the tea as measured by the Salmonella typhimurium mutagenicity assay, the hydrogen donating ability, and the superoxide anion radical scavenging assay.[30] The researchers suggest that fermented rooibos may show less antioxidant and antimutagenic activity because it has less polyphenols than unfermented rooibos. One analysis showed that polyphenols represent about 41% of the total solid matter in unfermented rooibos tea extract, but only about 30% of the total solid matter in fermented rooibos tea extract.[29]

One of the authors of both these studies is senior research scientist Jeanine Marnewick of the Program on Mycotoxins and Experimental Carcinogenesis at the Medical Research Council of South Africa. She says, "Rooibos showed protective effects against DNA damage when tested in an in vitro assay as well as in an in vivo animal system."[31] The in vitro studies found unfermented rooibos was generally more

protective against DNA damage than fermented rooibos. But Marnewick says her group's research shows that fermented rooibos has a stronger effect against some mutagens. She says, "Both the fermented and unfermented rooibos showed a significant protection, and we're busy elucidating the mechanisms."[31] She is currently evaluating the protective effect of rooibos on liver, esophageal, colon, and skin cancer induced in live animal models. The studies are in the early phases and she cautions, "Very little is known about the effect of rooibos on cancer development."[31]

Joubert also adds a cautionary note, saying that many questions about rooibos still need to be answered.[5] She says that researchers need to determine which of the antioxidant substances in rooibos tea are absorbed by the body and how many cups of tea are needed to produce a measurable benefit. She also emphasizes that no human studies have been conducted yet.

The full benefits of teas are likely to come from a combination of all the antioxidants in them rather than from just one substance. Some studies have found that isolated antioxidants don't have as positive an anticancer effect as the mixture of antioxidants found in natural food sources; whole apple extracts were better than pure quercetin at inhibiting the growth of cancer cells in vitro,[32,33] tomato powder was better than pure lycopene at extending the life of rats with prostrate tumors,[32,34] and freeze-dried strawberries exhibited better anticancer properties in animals than did pure ellagic acid.[32,35] Also, white and green tea extracts demonstrated better anticancer properties in vitro than mixtures of the top nine polyphenols found in the teas (mixed according to their relative proportions in the teas).[36] Researchers believe these results indicate that other substances in the whole food products besides the identified antioxidants probably

contribute to the total anticancer effect of the food, and that the relative amounts of all these substances could be important. Different teas have different mixtures of antioxidants, and they will protect against different mutagens. Sorting out all of these interactions will take time.

Rooibos Lore

Although rooibos does contain active antioxidants, many of the other health claims made for rooibos tea aren't supported by science. For example, rooibos is not a source of vitamin C. Joubert says, "We have tested both the traditional rooibos and green rooibos, and vitamin C was not present."[5] Minerals are present in trace amounts, but not in enough quantity to be a meaningful dietary source.

Distributors of rooibos tea often suggest it can help allergies, sleep problems, digestive problems, headache, and other ailments, but these claims have not been studied yet. South Africans use rooibos as a treatment for colic in babies; Joubert says the tea does seem to help infant colic, but no formal research has been done.[5]

Despite what is said in some promotional material, there's no evidence that rooibos tea fights the HIV virus. This inaccurate claim probably arose because one study found that a polysaccharide in rooibos leaves may have antiviral activity against the HIV virus, but the polysaccharide had to be chemically extracted from the leaves and is not found in tea made by steeping the leaves in water.[37] An in vitro and in vivo study showed that rooibos might enhance immune function, but very little research has been done on this topic.[38]

The Bottom Line

Rooibos tea has become popular because of its fruity, sweet taste and its caffeine-free, low tannin, antioxidant-rich status. Although more research is needed, rooibos seems to be safe and to have no side effects. The antioxidants in the tea might help protect against free radical damage that can lead to cancer, heart attack, and stroke. Future research should reveal whether the antioxidant benefits of rooibos observed in vitro and in animals will translate into health benefits for humans.

[table starts]

Table 1:

Flavonoids in Aqueous Extract of Fermented Rooibos (mg/g +/- SD)

isoorientin	0.833 +/- 0.007
orientin	1.003 +/- 0.010
aspalathin	1.234 +/- 0.010
vitexin	0.330 +/- 0.002
rutin	1.269 +/- 0.006
isovitexin	0.265 +/- 0.002
isoquercitrin and hyperoside	0.429 +/- 0.002
luteolin	0.029 +/- 0.001
quercetin	0.107 +/- 0.002
chrysoeriol	0.022 +/- 0.001
total	5.521 +/- 0.003

Source: Bramati L, Minoggio M, Gardana C, Simonetti P, Mauri P, Pietta P. Quantitative characterization of flavanoid compounds in Rooibos tea (Aspalathus linearis) by LC-UV/DAD. J Agric Food Chem 2002 Sep 25;50(20):5513-9.

Note: The extracts were prepared using 1 gram of rooibos in 60 ml of hot distilled water, steeped for 10 minutes. After removing the tea leaves, the solution was cooled and filtered. The table gives the amounts of flavonoids in mg per gram of extract.

[table ends]

[sidebar starts]

Sources For Rooibos Tea

Republic of Tea (www.republicoftea.com, 1-800-298-4TEA)
Special Teas (www.specialteas.com, 1-888-enjoy-tea)
Culinary Café (www.culinarycafe.com, 1-866-799-4005)
Strand Tea (www.strandtea.com, 1-888-718-6358)

[sidebar ends]

Acknowledgments

I would like to thank Elizabeth Joubert, PhD, specialist researcher at South Africa's ARC Infruitec-Nietvoorbij, and Jeanine L. Marnewick, senior research scientist at the Program on Mycotoxins and Experimental Carcinogenesis at the Medical Research Council of South Africa, for their quotes and technical input. Their expertise on rooibos has contributed much valuable information to this article. They also provided copies of three research papers, which I greatly appreciate. I would also like to thank Lorenzo Bramati, PhD, research scientist at the Instituto Tecnologie Biomediche CNR in Italy, for his helpful input and for providing copies of three research papers.

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