ROOIBOS RESEARCH

2009 – 2013

THE SCIENCE BEHIND ROOIBOS
SOUTH AFRICA'S UNIQUE AND HEALTHY HERBAL TEA

ANTIOXIDANT EFFECTS

In this 10-week study, 80 male rats were treated with a liver-damaging chemical known as t-BHP (Tert-butyl hydroperoxide). Giving these rats access to Rooibos (instead of water) helped to protect the liver against structural, enzymatic and biochemical damage, and could even reverse some of the damage. These findings provide solid evidence that **Rooibos can improve liver function and protect the liver** against oxidative damage.

Ajuwon et al., 2013. Protective effects of rooibos (*Aspalathus linearis*) and/or red palm oil (*Elaeis guineensis*) supplementation on tert-butyl hydroperoxide-induced oxidative hepatotoxicity in Wistar rats. Evidence-based complementary and alternative medicine : eCAM, 2013. Available at: http://dx.doi.org/10.1155/2013/984273

In the first study to examine the antioxidant activity of Rooibos on meat products, researchers found that **unfermented Rooibos increased the shelf-life of ostrich patties** by delaying the oxidative degradation of meat fat. Fermented Rooibos also slowed fat oxidation in ostrich salami. These promising preliminary results merit further studies into how the tea exerts its protective effect, and whether any long-term effects exist.

Cullere, M., Hoffman, L.C. & Dalle Zotte, 2013. First evaluation of unfermented and fermented rooibos (*Aspalathus linearis*) in preventing lipid oxidation in meat products. *Meat Science*, 95(1), pp.72–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23659927

Researchers used *Caenorhabditis elegans*, a worm-like nematode, as a model to study the effect of Rooibos and aspalathin on oxidative stress. In high glucose environments Rooibos extracts and aspalathin **caused the nematodes to live longer and reduced evidence of oxidative stress**.

Chen et al., 2013. Ameliorative effect of aspalathin from rooibos (*Aspalathus linearis*) on acute oxidative stress in Caenorhabditis elegans. *Phytomedicine: International Journal of Phytotherapy and Phytopharmacology*, 20(3-4), pp.380–6. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23218401

Oxidative stress can negatively affect mammalian sperm. Fermented and unfermented Rooibos significantly improved the number of sperm produced by male rats that had undergone artificially-induced oxidative stress. Rooibos also improved sperm motility, which measures how well sperm are able to swim towards an egg to fertilise it. In other words, **Rooibos may improve male fertility (sperm quality and function).**

Awoniyi et al., 2012. The effects of rooibos (*Aspalathus linearis*), green tea (*Camellia sinensis*) and commercial rooibos and green tea supplements on epididymal sperm in oxidative stress-induced rats. *Phytotherapy Research*: PTR, 26(8), pp.1231–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22228422

Compared to rats that received only tap water, those that received Rooibos tea had **significantly less damage to their testicular tissue** after researchers injected the area with a chemical oxidative stressor. Oxidative stress is a prominent cause of defective sperm.

Awoniyi et al., 2011. Protective effects of rooibos (*Aspalathus linearis*), green tea (*Camellia sinensis*) and commercial supplements on testicular tissue of oxidative stress-induced rats. *African Journal of Biotechnology*, 10(75), pp.17317–17322. Available at: http://www.academicjournals.org/AJB/abstracts/abs2011/28Nov/Awoniyi et al.htm

A human study with 15 healthy volunteers proved for the first time that the antioxidants in Rooibos are potent enough to **measurably elevate the antioxidant levels in blood**, thereby boosting the body's internal defence systems against disease. The effect peaks about one hour after drinking 500 ml Rooibos tea.

Villaño et al., 2010. Unfermented and fermented rooibos teas (*Aspalathus linearis*) increase plasma total antioxidant capacity in healthy humans. *Food Chemistry*, 123(3), pp.679–683. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0308814610005923

A Japanese study showed that Rooibos could **reduce inflammation in rats with colitis** (open sores in the colon) via increased antioxidant activity with a consequent reduction in damage to DNA caused by oxidation. These researchers recommend Rooibos as a safe and useful way to reduce oxidative stress.

Baba et al., 2009. Studies of anti-inflammatory effects of Rooibos tea in rats. *Pediatrics International*, 51(5), pp.700–4. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19419525

ANTI-DIABETIC EFFECTS

Using a cell model (muscle cells) researchers have confirmed that unfermented rooibos extract is able to **alleviate the development of insulin resistance** and to improve the cells' uptake of glucose. This means that Rooibos could play a key role in the prevention of diabetes.

Mazibukoa et al. 2013, Amelioration of palmitate-induced insulin resistance in C2C12 muscle cells by rooibos (*Aspalathus linearis*). *Phytomedicine*, 20(10), pp.813–819. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23083813

Researchers found that aspalathin-enriched "green" Rooibos extract and aspalathin **decreased blood glucose levels**. They used *in vitro* and *in vivo* methods to obtain their results. Aspalathin, in combination with rutin, another Rooibos polyphenol, performed even better. This suggests that the polyphenols might interact to create a greater hypoglycaemic effect.

Muller et al., 2012. Acute assessment of an aspalathin-enriched green rooibos (*Aspalathus linearis*) extract with hypoglycemic potential. *Phytomedicine*, 20(1), pp.32–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23083813

The results of this study strongly suggest that **aspalathin, a major polyphenol in Rooibos, has anti-diabetic potential.** The authors found that the compound affects the cellular signalling pathways involved in glucose metabolism, and that it reduces the expression of certain genes that code for liver enzymes involved in glucose and fat production. Mice were used as a model of Type 2 diabetes, along with cell lines.

Son et al., 2012. Aspalathin improves hyperglycemia and glucose intolerance in obese diabetic ob/ob mice. *European Journal of Nutrition*. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23238530

According to this study, **aspalathin** helped to improve the glucose uptake of muscle cells (and thereby **helped to maintain normal blood sugar levels**) in mice with type 2 diabetes. Aspalathin also stimulates pancreatic beta-cells to secrete insulin and helps to improve impaired glucose tolerance in these animals.

Kawano et al., 2009. Hypoglycemic effect of aspalathin, a rooibos tea component from *Aspalathus linearis*, in type 2 diabetic model db/db mice. *Phytomedicine*, 16(5), pp.437–43. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19188054

CARDIOVASCULAR PROTECTION

Rooibos and its polyphenols aspalathin and nothofagin caused a four-fold **reduction in the total steroids produced by an adrenal gland cell line.** The tea especially reduced the amount of precursors of aldosterone, a blood pressure-related hormone, and cortisol, a stress hormone. Imbalances and elevated levels of adrenal hormones are associated with hypertension, cardiovascular disease and type 2 diabetes, so Rooibos may be considered as a potential therapy for these ailments.

Schloms et al., 2012. The influence of *Aspalathus linearis* (Rooibos) and dihydrochalcones on adrenal steroidogenesis: Quantification of steroid intermediates and end products in. *The Journal of Steroid Biochemistry and Molecular Biology*, 128, pp.128–138. Available at: http://www.sciencedirect.com/science/article/pii/S0960076011002226

Forty human volunteers consumed six cups of fermented Rooibos daily for six weeks, after which researchers assessed heart, liver and kidney function using various biochemical indicators. They found that the tea **significantly reduced LDL-cholesterol, the "bad" cholesterol**, and increased HDL-cholesterol, the "good" cholesterol. This is the first study to provide clinical evidence that regular Rooibos consumption improves blood lipid status. The study also found that the anti-oxidant activity of the tea could be relevant in reducing the risk of developing cardiovascular disease. More research is needed, but the results of this study are a promising start to confirm the health-promoting properties of Rooibos in people.

Marnewick et al., 2011. Effects of rooibos (*Aspalathus linearis*) on oxidative stress and biochemical parameters in adults at risk for cardiovascular disease. *Journal of Ethnopharmacology*, 133(1), pp.46–52. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20833235

Researchers found that the hearts of rats who had consumed Rooibos extracts for seven weeks were **protected against the effects of ischemia, or a restriction of blood supply**, more so than if they had consumed regular *Camellia sinensis* tea. The researchers had artificially restricted and then restored blood supply to the rat hearts, thereby causing oxidative stress in the tissue. Rooibos seemed to protect against this injury and they suggested that this may be due to an inhibition of cell death by the flavonols present in the tea.

Pantsi et al., 2011. Rooibos (*Aspalathus linearis*) offers cardiac protection against ischaemia/reperfusion in the isolated perfused rat heart. *Phytomedicine*, 18(14), pp.1220–8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21982437

A South African study in humans showed that taking **six cups of Rooibos every day** for a period of six weeks **significantly reduced several of the pertinent biomarkers associated with cardiovascular disease** and protects the body against oxidative damage of blood lipids. The liver and kidney functions of the 40 participants were monitored and no adverse effects from taking six cups of rooibos per day were found.

Marnewick, J.L., 2010. Rooibos and honeybush: Recent advances in chemistry, biological activity and pharmacognosy. In: African natural plant products: New discoveries and challenges in chemistry and quality; Juliani, H.R., Simon, J.E., Ho, C.T. (Eds). ACS Symposium Series Volume 1021, American Chemical Society, Washington DC, USA, pp 277–294.

Chrysoeriol, an antioxidant present at low levels in Rooibos, can **prevent and treat vascular disease in humans**. Chrysoeriol is able to inhibit the migration of smooth muscle cells inside the aorta, a key cause of atherosclerosis (narrowing or hardening of the arteries). The research was done on human aorta cells. **Scientists therefore recommend the use of chrysoeriol to prevent and treat the repeated narrowing of blood vessels following coronary angioplasty.** During angioplasty, a small balloon is used to open up a blocked or narrowed heart artery. (Note: Often only trace quantities of chrysoeriol are found in Rooibos.)

Cha et al., 2009. An inhibitory effect of chrysoeriol on platelet-derived growth factor (PDGF) -induced proliferation and PDGF receptor signaling in human aortic smooth muscle cells. *Journal of Pharmacological Science*, 110, pp.105–110

IMMUNE-REGULATION

Rooibos tea was found to affect the concentration of biomarkers for inflammation and immunity in whole blood cultures. These findings suggest that **Rooibos is able to modulate immune function** *in vitro*. Further *in vivo* studies could shed more light on whether Rooibos could be used as a dietary supplement to suppress or enhance immunity as needed.

Hendricks, R. & Pool, E.J., 2010. The in vitro effects of rooibos and black tea on immune pathways. *Journal of Immunoassay & Immunochemistry*, 31(2), pp.169–80. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20391028

ANTI-OBESITY EFFECTS

This study suggests that daily consumption of Rooibos could aid the management of metabolic diseases and obesity. In mice that had high blood lipid levels, especially those that had consumed an unhealthy diet, **Rooibos was found to lower serum cholesterol, triglyceride and free fatty acid concentrations**. The tea also prevented the abnormal retention of lipids within liver cells, and it reduced the size and number of fat cells.

Beltrán-Debón et al., 2011. Continuous administration of polyphenols from aqueous rooibos (*Aspalathus linearis*) extract ameliorates dietary-induced metabolic disturbances in hyperlipidemic mice. *Phytomedicine*, 18(5), pp.414–24. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21211952

ANTI-CANCER PROPERTIES

Rooibos extracts were found to **reduce the number and size of chemically-induced oesophageal tumours** in rats. In fact, unfermented extracts reduced the average total papilloma size by 87%. The polyphenols present in the tea leaves are thought to be responsible for this anti-cancer effect.

Sissing et al., 2011. Modulating effects of rooibos and honeybush herbal teas on the development of esophageal papillomas in rats. *Nutrition and Cancer*, 63(4), pp.600–10. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21541901

BIOAVAILABILITY & SAFETY

Using urine samples from 12 healthy men who had consumed Rooibos, **researchers found that aspalathin and nothofagin, major Rooibos antioxidants, are metabolised in the body** so that it is easier for the body to excrete the metabolites. This means that the compounds are available for use by the body (bioavailability) and are not simply excreted in the same form that they are ingested.

Breiter et al., 2011. Bioavailability and antioxidant potential of rooibos flavonoids in humans following the consumption of different rooibos formulations. *Food Chemistry*, 128(2), pp.338–347. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0308814611004109

Joint research between the Agricultural Research Council and the Medical Research Council were able to show that two Rooibos antioxidants – aspalathin and nothofagin – are changed by liver enzymes *in vitro.*

Van der Merwe et al., 2010. In vitro hepatic biotransformation of aspalathin and nothofagin, dihydrochalcones of rooibos (*Aspalathus linearis*), and assessment of metabolite antioxidant activity. *Journal of Agricultural and Food Chemistry*, 58(4), pp.2214–20. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20039677

A study in Italy found flavonoid metabolites in the urine of ten human volunteers after they had drunk 500 ml green and fermented Rooibos. Most metabolites were excreted within five hours of tea consumption.

Stalmach et al., 2009. Bioavailability of C-linked dihydrochalcone and flavanone glucosides in humans following ingestion of unfermented and fermented rooibos teas. *Journal of Agricultural and Food Chemistry*, 57(15), pp.7104–11. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19534535

The metabolism of aspalathin was confirmed in humans in a collaborative study by researchers in the UK and Switzerland. They found metabolites of aspalathin in the urine of the study participants.

Courts, F.L. & Williamson, G., 2009. The C-glycosyl flavonoid, aspalathin, is absorbed, methylated and glucuronidated intact in humans. *Molecular Nutrition & Food Research*, 53(9), pp.1104–11. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19653227

OTHER RESEARCH – SENSORY, INDUSTRY & AGRICULTURAL POTENTIAL

The phenolic content of Rooibos is affected by seasonal production variations, quality grade and steam pasteurisation. Researchers found that **grade A (the highest quality) samples contained a higher content of almost all phenolics**. They also determined that steam pasteurisation decreased the content of the majority of phenolic compounds in a 'cup-of-tea' strength rooibos infusion.

Stanimirova et al., 2013. High-dimensional nested analysis of variance to assess the effect of production season, quality grade and steam pasteurization on the phenolic composition of fermented rooibos herbal tea. Talanta, 115, pp.590–599. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0039914013005237

Scientists have isolated and analysed a compound thought to contribute to the taste and mouthfeel of fermented Rooibos. The compound is known as Z-2-(β-D-glucopyranosyloxy)-3-phenylpropenoic acid (PPAG) and it has a slightly bitter to astringent taste. It was not always present in high enough quantities to detect in unfermented tea leaves, and this leads to large variation in the fermented plant material, infusions and food-grade extracts.

Joubert et al., 2013. Occurrence and sensory perception of Z-2-(b-D-glucopyranosyloxy)-3-phenylprop- enoic acid in rooibos (*Aspalathus linearis*). *Food Chemistry*, 136, pp.1078–1085. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23122165

Researchers found **substantial variation in the polyphenolic content and total antioxidant capacities of different production seasons and quality grades** of Rooibos.

Joubert et al., 2012. Variation in phenolic content and antioxidant activity of fermented rooibos herbal tea infusions: role of production season and quality grade. *Journal of agricultural and food chemistry*, 60(36), pp.9171–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/22920220

This article describes how a sensory wheel was developed to help standardise the terminology and quality of Rooibos tea. Using the wheel, **Rooibos teas can now be thoroughly described in terms of taste, flavour and mouthfeel.** As such, the "characteristic" Rooibos flavour is described as "a combination of honey, woody and herbal-floral notes, with a slightly sweet taste and subtle astringency".

Koch et al., 2012. Sensory characterization of rooibos tea and the development of a rooibos sensory wheel and lexicon. *Food Research International*, 46(1), pp.217–228. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0963996911006715

This study found that the total antioxidant capacity of infused Rooibos tea was slightly higher than that of Rooibos hot water extracts. The total polyphenol and aspalathin contents were equivalent, while the isoorientin and orientin contents of the infusion were found to be slightly higher than those of the extract. Hot water extracts are increasingly used as an ingredient in ready-to-drink beverages and a variety of food products.

Joubert, E. & Beer, D. De, 2012. Phenolic content and antioxidant activity of rooibos food ingredient extracts. *Journal of Food Composition and Analysis*. Available at: http://www.sciencedirect.com/science/article/pii/S088915751200052X

Steam pasteurisation significantly reduces the amount of certain polyphenols in Rooibos, including the antioxidant aspalathin. It also affects the aroma and flavour of the tea, and decreases the astringency slightly.

Koch et al., 2012. Impact of steam pasteurization on the sensory profile and phenolic composition of rooibos (*Aspalathus linearis*) herbal tea infusions. *Food Research International*. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0963996912004280

This review article summarises the scientific data available on the health effects of Rooibos, including the animal models used and whether the tea was fermented or unfermented. The long list includes activities against cholesterol, high blood sugar, fat cell development, oxidative stress, heart disease, inflammation, wrinkles, cancer, sun damage and liver damage. The paper also mentions that Rooibos is actually not a valuable source of nutrient minerals like Vitamin C and iron, as is sometimes claimed in promotional material.

Joubert, E. & de Beer, D., 2011. Rooibos (*Aspalathus linearis*) beyond the farm gate: From herbal tea to potential phytopharmaceutical. *South African Journal of Botany*, 77(4), pp.869–886. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0254629911001086

The success of Rooibos highlights the potential of indigenous, multi-purpose food crops to alleviate poverty in Africa through income-generating produce, because such crops are well adapted to harsher African growing conditions.

Sprent, J.I., Odee, D.W. & Dakora, F.D., 2010. African legumes: a vital but under-utilized resource. *Journal of Experimental Botany*, 61(5), pp.1257–65. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19939887

Notes:

1. *In vitro* (Latin: in glass) studies are conducted in the laboratory, and commonly called "test tube experiments".
2. *In vivo* studies are conducted with living organisms in their normal intact state (such as animal studies or clinical trials).
3. *Ex vivo* studies are conducted on functional organs that have been removed from the intact organism (for example, studies on living cell lines).

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