

Furthermore, the isolation of 3,4-dihydroxybenzoic acid [3] and a number of glycans referred to as eleutherans A, B, C, D, E, F, and G [4] have also been reported.

The amount of syringin, isofraxidin, and total flavones were highest in the root, rhizome, and stem. Syringin and isofraxidin were not found in the leaf and fruit, whereas a large amount of total flavone was present in the leaf. The amounts of the above mentioned constituents in the root, rhizome, and stem were highest during May and October and lowest in July. The amounts were also different in *A. senticosus* collected from various geological regions [5]. In the root and rhizome of *A. senticosus* a syringin yield of 0.03% was obtained [6]. The syringin content in powdered roots or rhizomes decreased to 50% of the original value after 12 months storage and could no longer be detected after 3 years of storage under regular conditions [7].

### 1.3 Pharmacology

The water extract of *A. senticosus* prevented stress-induced decreases in rectal temperature and body and grip tonus and accelerated recovery from decreases in body and grip tonus in acutely stressed mice. These effects were attributed to syringin and syringaresinol-di-*O*-glucoside [8]. The water extract and syringaresinol also protected mice from stress-induced decreases in sex behaviour. They had no effect, however, on stress-induced increases in tyrosine hydroxylase activity in adrenal gland and hypothalamic regions and on corticosterone contents in adrenal gland and serum [9].

The extract of *A. senticosus* at a single i. p. dose of 40–320 mg/kg or at a dosage of 80–320 mg/kg within 4–5 days produced a sedative effect, resulting in increased sleep duration. It was also shown to produce an inhibition of hexobarbital metabolism in vitro, supporting enzyme inhibition rather than enzyme induction as a mechanism for its actions [10].

The alcohol extract of *A. senticosus* inhibited protein synthesis in cell-free rat liver microsomal systems to a greater extent than in polyribosomal systems. This effect was found to be concentration dependent. The water extract had less inhibitory activity and the pure glycosides, eleutherosides B and D, inhibited protein synthesis 10–20 times more than did the alcohol extract [11]; however, i.p. administration of the alcohol extract to rats stimulated protein biosynthesis in the pancreas, liver, and adrenal glands. The results are consistent with the observation that high levels of eleutheroside accumulate in adrenal glands [12].

Intraperitoneal administration of an extract containing mainly eleutherosides B and D to mice at daily dose of 18 mg/animal for 1 week increased the cytostatic activity of natural killer cells by about 200%. It appeared that the eleutherosides stimulated macrophagal T cell and possibly B cell mediated immunity [13]. A recent study on the immunomodulatory activity of the ethanol extract of *A. senticosus* administered orally to healthy volunteers for 4 weeks, showed a drastic increase in the absolute number of immune competent cells, especially T lymphocytes. No side effects were observed within 6 months [14].

Treatment of rats with an extract of *A. senticosus* for 14 days before  $\gamma$ -irradiation accelerated the restoration of blood nucleic acid levels to normal, delayed the nadir in blood leukocyte count for 1–3 days, and increased leukocyte count on days 10–30