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Note on Pharmacological Activities of *Calendula officinalis* L.

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Calendula officinalis, known as Pot Marigold or English Marigold, is a plant in the Calendula genus. Calendula officinalis is used for the treatment of skin disorders and pain, and as a bactericide, antiseptic and anti-inflammatory. The petals and pollen contain triterpenoid esters (an anti-inflammatory) and the carotenoids flavoxanthin and auroxanthin (antioxidants, and the source of the yellow-orange coloration). The leaves and stems contain other carotenoids, mostly lutein (80%) and zeaxanthin (5%), and beta-carotene. Plant extracts are also widely used by cosmetics, presumably due to presence of compounds such as saponins, resins and essential oils.

Phagocytosis

Three polysaccharides isolated from an aqueous extract of Flos Calendulae enhanced phagocytosis in human granulocytes in vitro in the colloidal carbon clearance test[1]. Intraperitoneal injection of a

polysaccharide fraction isolated from an aqueous extract of the flowers to mice (10 mg/kg body weight) enhanced phagocytosis[4]. Intraperitoneal administration of an unsaponifiable fraction (0.5 ml) of a hydroalcoholic extract of the flowers weakly stimulated phagocytosis in mice inoculated with *Escherichia coli*. However, the hydroalcoholic extract was not active[5].

Antimicrobial activity

The essential oil of the flowers inhibited the growth in vitro of *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albican*[6]. A flavonoid fraction isolated from the flowers inhibited the growth in vitro of *S. aureus*, *Sarcina lutea*, *E. coli*, *Klebsiella pneumoniae* and *Candida monosa*[7]. However, chloroform, ethanol, methanol or water extracts of the flowers did not inhibit bacterial growth in vitro[8-10]. Acetone, ethanol or water extracts inhibited the growth in vitro of the fungus *Neurospora crassa*[11]. Extracts of the flowers inhibited the growth in vitro of *Trichomonas vaginalis*[12]. Oxygenated terpenes appear to be responsible for the antimicrobial activity[13].

Antiviral activity

A tincture of the flowers suppressed the replication of herpes simplex, influenza A2 and influenza APR-8 viruses in vitro[14]. However, an aqueous extract of the flowers was not active[14]. A chloroform extract of the flowers inhibited the replication of HIV-1 in acutely infected lymphocytic MOLT-4 cells in vitro (IC50 0.4 mg/ml)[15]. A chloroform extract also inhibited HIV-1 reverse transcriptase activity in a dose-dependent manner (ED50 51.0 mg/ml). A 5% hot aqueous extract of the flowers (2 ml) inhibited the replication of encephalitis virus after intraperitoneal administration to mice[16].

Anti-inflammaory activity

Topical application of a 70% ethanol extract of the flowers to mice at a dose of 1.2 mg/ear

(corresponding to 4.16 mg crude drug) reduced croton oil-induced ear oedema by 20%[17]. External application of a carbon dioxide extract of the flowers (300 mg/cm2) suppressed croton oil-induced ear oedema in mice[18]. The triterpene fraction of an extract of the flowers had marked anti-inflammatory activity in mice (1 mg/ear) against ear oedema induced by 12-*O*tetradecanoylphorbol- 13-acetate[19]. Faradiol esters isolated from the flowers (240 mg/cm2) inhibited croton oil-induced ear oedema in mice[20]. Intragastric administration of an aqueous extract of the flowers (100 mg/kg body weight) inhibited carrageenan-induced footpad oedema in rats[21]. However, an 80% ethanol extract of the flowers was weakly active (11% inhibition) at a concentration of 100 mg/kg body weight administered orally 1 hour prior to induction of oedema[22]. Isorhamnetin glycosides isolated from the flowersinhibited rat lung lipoxygenase in vitro[23].

Wound-healing activity

External application of a hydroalcoholic extract accelerated the rate of contraction and epithelialization of excision wounds in rats[24]. A 3% freeze-dried aqueous extract of the flowers induced vascularization in the chick chorioallantoic membrane assay. Histological sections of the treated chorioallantoic membranes also indicated the presence of hyaluronan, a tissue glycosaminoglycan associated with neovascularization[25].

Clinical pharmacology

Although no randomized, controlled clinical trials have been performed, two case reports in the early medical literature support the traditional use of Flos Calendulae. The reports describe the use of a strong tincture of the flowers applied on compresses to reduce inflammation and suppuration, and to accelerate the healing of wounds [26, 27].

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