The extraction method and formulation of *Zingiber cassumunar* Roxb. (Plai) : A review

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Abstract

Zingiber cassumunar Roxb. (Plai) is a medicinal plant widely cultivated in Thailand and tropical Asia for Thai traditional fields. The rhizome of Zingiber cassumunar Roxb. has an activity that helps reduce inflammation. It is more frequently used as an ingredient in marketed phytomedicines. This review aimed firstly to present the extraction method of Zingiber cassumunar Roxb. rhizome, using different organic solvents, such as chloroform, hexane, and methanol that obtain the mainly various phenylbutanoid derivatives such as ((E)-4-(3,4-dimethoxyphenyl)but-3-en-l-ol (compound I), (E)-4-(3, 4-dimethoxyphenyl)but-3-en-l-yl acetate (compound II), (E)-4-(3,4-dimethoxyphenyl) but-3-en-1-O-□-D-glucopyranoside (compound III), (E)-1-(3, 4-dimethoxyphenyl)butadiene (compound IV), (E)-4-(2,4,5-trimethoxyphenyl)-but-1,3-diene (compound V), (E)-trans-3-(3,4-dimethoxyphenyl)-4-[(E)-3,4-dimethoxystyryl] cyclohex-1-ene (compound VI), and (E)-trans-3-(4-hydroxy-3-methoxyphenyl)-4-[(E)-3,4-dimethoxystyryl]cyclohex-1-ene (compound VII). It has been specially reported that the anti-inflammatory active constituents are compound I, II, V, and VI. The second aim was to suggest the preparation of Zingiber cassumunar Roxb. in new formulations such as emulsions and gels. The oil extract from Zingiber cassumunar Roxb. can be appropriately prepared for further applications in cosmetic or medical applications.

Keywords : Zingiber cassumunar Roxb., Plai, Method, Formulation, and Thai herb

Introduction

Zingiber cassumunar Roxb., also known as Thai name "Plai", is a species of plant in the Zingiberaceae or ginger family. It is relative to tropical ginger which is widely distributed in Southeast Asia (Han et al. 2005; Mabberley 2008). Zingiberaceae is a family of flowering plants consisting of aromatic perennial herbs with creeping horizontal or tuberous rhizomes. The rhizomes of *Zingiber cassumunar* Roxb. are bigger and more bulbous than ginger. They have been the source of Thai traditional herbal remedies and extracts for application onto the skin to alleviate inflammation (Janpim et al. 2011; Kaewchoothong et al. 2012; Panthong et al. 1990). The rhizomes are also used to beautify the skin, learns it nourished, smooth with improved and fairness. In addition, it can be used to improve relaxation and freshness. Moreover, it is hailed toward off asthma, chronic colds, and nausea. It is also used as an antiseptic, an analgesic, an inflammatory, a digestive, and reduces fever, diarrhoea, anaemia, oedema anasarca, asthma, bronchitis, and is an antidote to snake bites (Bordoloi *et al*. 1999; Janpim *et al*. 2011; Jeenapongsa *et al*. 2003; Kaewchoothong *et al*. 2012; Ozaki et al. 1991; Panthong *et al*. 1997).

The chemical composition of the rhizome oils of *Zingiber cassumunar* Roxb. has been studied previously (Bordoloi et al. 1999; Han *et al*. 2005; Jeenapongsa *et al*. 2003; Kaewchoothong *et al*. 2012; Masuda, Jitoe 1995; Ozaki et al. 1991; Panthong et al. 1997). The major constituent of the

crude oils are terpinen-4-ol, α- and β-pinene, sabinene, myrcene, α- and γ-terpinene, limonene, terpinolene, sabmene, and monoterpenes (Bhuiyan *et al*. 2008; Bordoloi *et al*. 1999). However, phytochemical work on the rhizomes of *Zingiber cassumunar* Roxb. reports that various types of phenylbutanoid compound are found to have diverse biological activities such as cytotoxic, antioxidant, anti-insecticidal, anti-inflammatory, and uterine relaxant activity including (E)-4-(3,4-dimethoxyphenyl)but-3-en-l-ol (compound I), (E)-4-(3, 4-dimethoxyphenyl)but-3-en-l-yl acetate (compound II), (E)-4-(3,4-dimethoxyphenyl) but-3-en-1-O-β-D-glucopyranoside (compound III), (E)-1-(3, 4-dimethoxyphenyl)butadiene (compound IV), (E)-4-(2,4,5-trimethoxyphenyl)-but-1,3-diene (compound V), (E)-trans-3-(3,4-dimethoxyphenyl)-4-[(E)-3,4-dimethoxystyryl] cyclohex-1-ene (compound VI), and (E)-trans-3-(4-hydroxy-3-methoxyphenyl)-4-[(E)-3,4-dimethoxystyryl]cyclohex-1-ene (compound VII) (Han et al. 2005; Masuda, Jitoe 1995). However, it has been reported that the high and effective anti-inflammatory active constituents are compound I, II, V, and VI. Compound I (known as compound D) is the most effective anti-inflammatory (Han et al. 2005; Jeenapongsa *et al*. 2003; Kaewchoothong et al. 2012; Panthong *et al*. 1997).

Zingiber cassumunar Roxb. extraction

Zingiber cassumunar Roxb. rhizome oils can be extracted using organic solvents such as chloroform, hexane, and methanol (Janpim *et al*. 2011). The methanol extract gives minimal irritation result by using the fibroblasts cells to represent human skin. Ozaka *et.al*. (1991) used the fresh rhizomes of *Zingiber cassumunar* Roxb. cultivated in the Bandung region. They suggest that the extraction of fresh rhizomes of *Zingiber cassumunar* Roxb. be done by the reflux method with 70% methanol for 6 hours with the method repeated three times. Then, the solution is filtered and evaporated to give the crude oil extract. The crude oil extracts are dissolved with ether and separated with water three times. The crude oil extracts are dissolved in ether fraction to show the compound IV, compound VI, and zerumbone. Inhibited of compound took effect from 30 minutes to 6 hours after a carrageenan injection. This compound is similarly to that of indomethacin on swelling of the paw induced by carrageenan in rats.

Two possible methods for essential oil extraction are steam distillation (Pongprayoon *et al*. 1997a) and hexane extract (Pongprayoon *et al*. 1997b). Both methods show the topical anti-inflammatory effect when they are tested with the model of carrageenan-induced hind paw edema in rats. They found compound VI extracted by steam distillation is the most active compound, and significantly inhibited edema formation. In opposite, the hexane extract showed various compounds (compound I, II, V, VI, and VII) which exerted potent topical anti-inflammatory activity similar to diclofenac, when tested in the model of 12-0-tetradecanoylphorbol-13-acetate-induced ear edema in rats.

Bhuiyan *et al*. (2008) used a hydrodistillation method using a modified Clevenger-type glass apparatus for 4 hours for isolation of leaf and rhizome of Zingiber cassumunar Roxb. to obtain the crude oil. These were then dried, filtered, and concentrated under reduced pressure at room temperature to obtain the essential oil for GC-MS analyses. 64 components were identified in the crude leaf oil, having main components such as sabinene, β-pinene, caryophyllene oxide, and caryophyllene. 32 components were identified in the rhizome crude oil, which had components such as triquinacene 1,4-bis (methoxy), (Z)-ocimene, and terpinen-4-ol.

Kaewchoothong *et. al*. (2012) used the reflux method for rhizome of *Zingiber cassumunar* Roxb. extract for 1 hour with different solvents such as hexane, chloroform, ethyl acetate, and methanol. They found that methanol extract produced the highest yield of the extract. However, hexane extract produced the highest content of the active phenylbutanoids for anti-inflammatory activity (compound I, II, VI, and VI).

Zingiber cassumunar Roxb. formulation

Normally, the oily phase is the oil extract obtained from *Zingiber cassumunar* Roxb.. It can be used in the form of creams or massage oil formulations, which may affect its product quality and shelf-life. This review presented the various formulation preparations for further applications in cosmetics or medicine. The 5% of essential oil of *Zingiber cassumunar* Roxb. can be prepared in gel formulation compared to tea tree oil, Garamycin® creams, and selected standard pharmaceutical drugs

such as ampicillin, ketoconazole, and Nizoral® (Pithayanukul *et al*. 2007). The essential oil of *Zingiber cassumunar* Roxb. exhibits antimicrobial activity against Gram-positive and Gram-negative bacteria, dermatophytes and yeasts. Dermatophytes are found to be the most susceptible microorganisms followed by yeasts, whereas bacteria were the least susceptible. Thus, in medical application, the essential oil of *Zingiber cassumunar* Roxb. can act as a naturally occurring antibacterial and/or antifungal agent when used as a topical antiseptic and for treatment of skin infections (Pongprayoon *et al*. 1997[a,b]).

Janpim *et al*. (2011) successfully prepared and developed the gel formulation of essential oil of *Zingiber cassumunar* Roxb., composed of Carbopol 940 and poly(vinyl alcohol), to obtain a clear gel. The in vitro permeation studied by using Franz diffusion cells using excised porcine ear skin as the barrier membrane. Compound I permeated via lipid channel and so this involved rapid permeation. Therefore, results showed that penetration started at the first hour and decreased as a result of a build-up.

The oil extract from *Zingiber cassumunar* Roxb. can be successfully prepared in an oil-in-water emulsion formulation, with positive charge of chitosan macromolecules and negatively charge of sodium dodecyl sulfate as an emulsifying system complex adding as a stabilizer by a one-step emulsification process (Sunintaboon *et al*. 2012). This preparation showed the interplay between bulk solution behavior and emulsion fabrication, and stability.

Conclusions

Zingiber cassumunar Roxb. (Plai) is a medicinal plant of Thai traditional herbal remedies in Thailand and tropical Asia. It can be successfully extracted with different method to obtain the oil phase with various biological activities, such as cytotoxic, antioxidant, anti-insecticidal, anti-inflammatory, and uterine relaxant actions. However, the oil extract can be appropriately prepared for further applications in cosmetics or skin medicines and has various biological activities, especially compound I which can alleviate inflammation.

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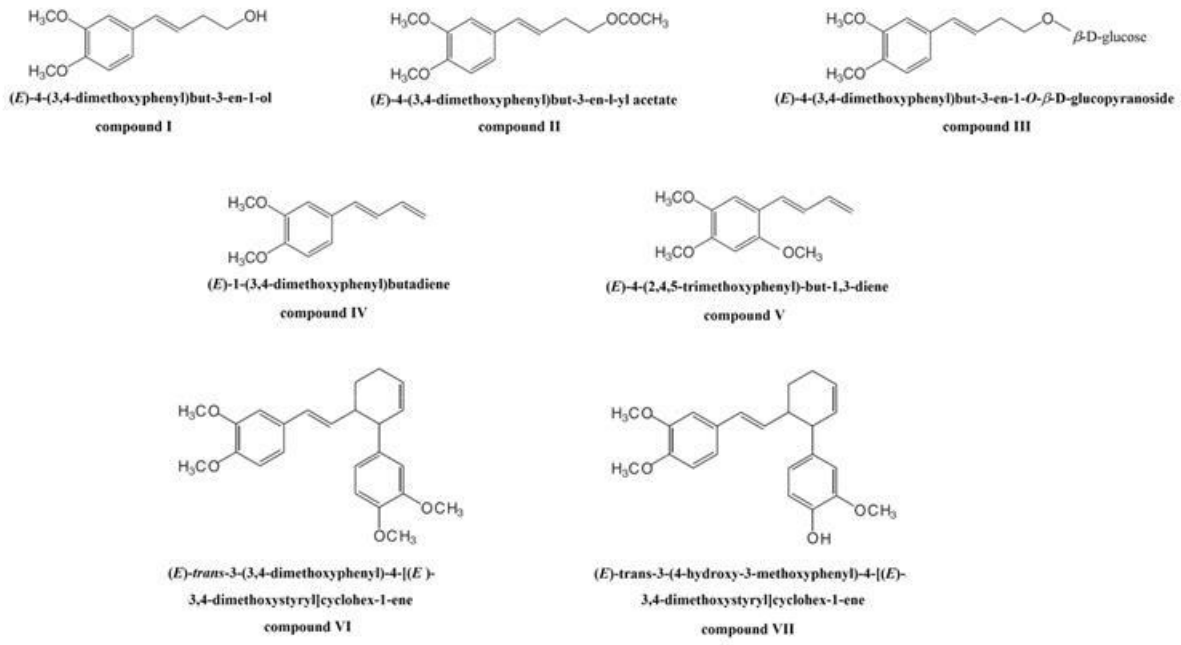

Figure 1 Chemical structures of various compounds from rhizome of Zingiber cassumunar Roxb. (Han et al. 2005; Kaewchoothong et al. 2012; Masuda, Jitoe 1995)