

during the approached period were considered not statistically significant. A period of 10 to 30 days may be adequate to obtain extracts enriched in triterpenoid acids with a minimal amount of undesirable phenols using the assayed conditions. These results establish parameters to obtain standardized tinctures from this specific raw material in terms of the triterpene acid-based medicinal content.

REFERENCES

- Neubeller J. Beziehungen zwischen der Wasserabgabe von Äpfeln und der Zusammensetzung der Fruchtschale. *Z Lebensm Unters Forsch* 1971;147:86-93.
- Huelin FE, Gallop RA. Studies in the natural coating of apples. I. Preparation and properties of fractions. *Aust J Sci Res* 1951;494:526-33.
- Kolattukudy PE. Natural waxes on fruits. *Postharvest PomolNews*1984;22. Available from: <http://postharvest.tfrec.wsu.edu/REP2003A.pdf>. [Last cited 2006 Dec 10].
- Ju Z, William J, Bramlage WJ. Phenolics and lipid-soluble antioxidants in fruit cuticle of apples and their antioxidant activities in model systems. *Postharvest Biol Technol* 1999;16:107-11.
- Liu J. Oleanolic acid and ursolic acid: Research perspectives. *J Ethnopharmacol* 2005;100:92-4.
- Yamaguchi H, Noshita T, Kidachi Y, Umetsu H, Hayashi M, Funayama S, *et al.* Isolation of ursolic acid from apple peels and its specific efficacy as a potent antitumor agent. *J Health Sci* 2008;54:654-60.
- Ma CM, Cai SQ, Cui JR, Wang RQ, Tu PF, Hattori M, *et al.* The cytotoxicity activity of ursolic acid derivatives. *Eur J Med Chem* 2005;40:582-9.
- Ellgardt K. Triterpenes in apple cuticle of organically and IP cultivated apples. Bachelor project, Danish-Swedish Horticulture programme, SverigesLantbruksUniversitet, Alnarp, Sweden, 2006.
- Jäger S, Trojan H, Kopp T, Laszczyk MN, Scheffler A. Pentacyclic triterpene distribution in various plants – Rich sources for a new group of multi-potent plant extracts. *Molecules* 2009;14:2016-31.
- Merck Research Laboratories. The Merck Index. 11th ed. Rahay: Merck and Co. Inc.; 1989. Entries 6964 and 10027, p. 1171 and 1686.
- Whitaker BD. Phenolic fatty-acid esters from the peel of 'Gala' apples and their possible role in resistance to superficial scald. *Postharvest Biol Technol* 1998;13:1-10.
- Wolfe KL, Liu RH. Apple peels as valuable-added food ingredient. *J Agric Food Chem* 2003;51:1676-83.
- Jäger S, Winkler K, Pfüller U, Scheffler A. Solubility of oleanolic acid and betulinic acid in aqueous solutions and plant extracts of *Viscum album* L. *Planta Med* 2007;73:157-62.
- Huelin FE. Studies in the natural coating of apples. *Aust J Biol Sci* 1959;12:175-80.
- Pridgen JH. Method and composition for relieving symptoms of arthritis and gout using fruit of miracles. USA Patent Appl. Pub. US 2005/0158410 A1, 07/21/2005.
- Waterhouse AL. Determination of Total Phenolics. In: Wrolstad RE, Acree TE, Decker EA, Penner MH, Reid DS, Schwartz SJ, *et al.*, editors. *Current Protocols in Food Analytical Chemistry*. New York: Wiley; 2002. p. 11.1.1-8.
- Tian S, Shi Y, Yu Q, Upur H. Determination of oleanolic acid and ursolic acid contents in *Ziziphora clinopodioides* Lam. by HPLC method. *Pharmacogn Mag* 2010;6:116-9.
- Lee MK, Ahn YM, Lee KR, Jung JH, Jung OS, Hong J. Development of a validated liquid chromatographic method for the quality control of *Prunellae Spica*: Determination of triterpenic acids. *Anal Chim Acta* 2009;633:271-7.
- Martelanc M, Vovk I, Simonovska B. Separation and identification of some common isomeric plant triterpenoids by thin-layer chromatography and high-performance liquid chromatography. *J Chromatogr A* 2009;1216:6662-70.
- Chen JH, Xia ZH, Tan RX. High-performance liquid chromatographic analysis of bioactive triterpenes in *Perilla frutescens*. *J Pharm Biomed Anal* 2003;32:1175-9.
- Jin IJ, Ko YI, Kim YM, Han SK. Solubilization of oleanolic acid and ursolic acid by cosolvency. *Arch Pharm Res* 1997;20:269-74.
- Frighetto RT, Welendorf RM, Nigro EN, Frighetto, N, Siani AC. Isolation of ursolic acid from apple peels by high speed counter-current chromatography. *Food Chem* 2008;106:767-71.
- Markley KS, Sando CE. Progressive changes in the waxlike coating on the surface of the apple during growth and storage. *J Agric Res* 1931;42:705-22.
- Markley KS, Sando CE. Progressive changes in the cuticle of apples during growth and storage. *J Agric Res* 1933;46:403-12.
- Schneider P, Hosseiny SS, Szczotka M, Schlitter JK. Rapid solubility determination of the triterpenes oleanolic acid and ursolic acid by UV-spectroscopy in different solvents. *Phytochem Lett* 2009;2:85-7.
- Massini L, Rico D, Diana AB, Barry-Ryan C. Valorisation of apple peels. *Eur J Food Res Rev* 2013;3:1-15.

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