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# The utilization of by-products of *Curcuma longa* Linn. by low pressure drying process associated with ultra high pressure extraction

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The root of *Curcuma long*a Linn. has been greatly used as a main source of curry in the world and many of its biological activities have also been reported. However, the ground parts of *Curcuma longa* Linn., especially leaves and stems of the plants have never been utilized after the roots being collected in the fall. Large quantities of these by-products or wastes often caused environmental problems in the farms. The studies on utilizing the by-products have never been paid attention to because its extraction and/or treating processing was not easy due to the characteristics of soft leaves and the existence of very low amounts of curcumin. The drying method could greatly affect its extraction yield and biological activities since the leaves were relatively soft and difficult to be treated after being dried. It has been proved that a freeze-drying method is most efficient method and widely employed. However, this process requires high amount input energy, long processing time, and man powers, which would not be proper in scaling-up treating large amounts of so cheap by-products. On the contrary, the hot-air drying process, most common and cheapest drying method for agricultural products, has several disadvantages of processing this by-product such as low extraction yields and degrading its biological activities by hot temperature. Therefore, simple and relatively cheap and efficient drying process was introduced to process the leaves and stems of *Curcuma longa* Linn. at 400-680 hPa of low vacuum drying condition and 25-30 °C for 4-8 hours. The extraction yield of this process was obtained as 14.9% under this condition, compared to 10.4% from freeze-drying and 9.7% from hot-air drying processes. However, the extraction yield was greatly increased up to 18.9% at 500 MPa for 30 min before being extracted, which was much higher that from freeze-drying method. The amount of key component, curcumin in the extracts was also high from low vacuum drying process such as 0.071 ppm vs 0.070 ppm from freeze-drying process, and this elution yields were much higher than that from hot-air drying process as 0.046 ppm. It was first reported that the drying process could affect on the extraction yield and its difference was caused by structural changes of the leaves during drying process from electron microscope observation. It was found that structure of the leaves from hot-air drying process was very dense and hard, which decreased the mass transfer of active compounds and caused low extraction and elution yields. This low extraction yield also caused low biological activities of 19.6% of antioxidant activities compared to 25.3% and 25.1% from vacuum drying and freeze drying process, respectively. We believe that these results could apply to process other relatively soft agricultural products such as leaves, flowers, etc., to maintain economical feasibility.

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