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Solubility Enhancement of Curcumin from Turmeric Oleoresin by Solid Dispersion Technique

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Abstract: The experiment was conducted to improve recovery and solubility of curcumin from Turmeric oleoresin (TO) by carrier (Polyethylene glycol 400, PEG 400) and adsorbent (Megnesium oxide, MgO) using the solid dispersion (SD) technique. The TO was mixed at the same ratio with carrier (1:1, w/w) and MgO was applied at a ratio of 0, 1, 2, 3 and 4 respectively. Mixed samples were determined for recovery solubility of curcumin quantity using the HPLC. The results showed that difference level of adsorbent had no effect on curcumin quantity. The ratio of 1:1:3 (TO: PEG 400: MgO) showed the highest recovery rate (81.47%). This ratio also showed higher solubility in water, while the ratio of 1:1:4 showed higher solubility in the 0.1 N hydrochloric acid solution (0.1 N HCl). It can be conducted that TO can be used as the source of curcumin in animal diet by mixed with carrier and adsorbent. The ratio of TO: carrier: adsorbent at 1:1:3 produced the highest recovery and solubility in water and in 0.1 N HCl.

Key words: Curcumin, solubility, solid dispersion

INTRODUCTION

Presently, consumers prefer lower fat in animal products because of perceived health benefits such as preventing obesity (Monique *et al*., 1996). It is possible that the administration of organic substance herbs in animal feed could be an option to decrease lipid and increase leanness animal products in market. Curcumin received considerable research interest because of the evidence suggestion that it may regulate lipid metabolism and may inhibits lipid accumulation in animal (Ruderman *et al*., 1999).

Curcumin is an active ingredient in Turmeric that is extracted from the rhizomes of *Curcuma longa*. It has limited aqueous solubility and is degraded at alkaline pH and when exposed to light and has a limited absorption in animal diets (Kochhar, 2008). The solubility rate of curcumin is a key factor determining the rate and extent of absorption after oral administration. The poor solubility of curcumin decrease efficiency of curcumin bioavailability. Solid dispersion (SD) technique has been used to increase the dissolution and absorption of poorly soluble drugs by dispersing the drug in water soluble carrier in a solid state (Lefebvre *et al*., 1985). This technique has been used to improve the solubility of some natural products such as silymarin, quercetin and rutin (Khaled *et al*., 2001). The objective of this research was to improve the solubility of curcumin by SD technique with different source carrier and adsorbent.

MATERIALS AND METHODS

The SD technique was prepared by mixed Tumeric oleoresin (TO) with carrier (Polyethylene glycol 400, PEG400) and adsorbent (Megnesium oxide, MgO) at a difference weight ratio (w/w). Source of curcumin was provided from TO with constant level of carrier (PEG 400; 1:1, w/w) and 4 levels of adsorbent (MgO; 1, 2, 3 and 4, w/w). The four treatments of research were:

T0, TO: carrier: adsorbent = 1:0:0; control
T1, TO: constant carrier: vary adsorbent = 1:1:1
T2, TO: constant carrier: vary adsorbent = 1:1:2
T3, TO: constant carrier: vary adsorbent = 1:1:3
T4, TO: constant carrier: vary adsorbent = 1:1:4

The TO was mixed in ethyl acetate and the PEG400 and MgO were added. Crude curcumin, carrier (PEG400) and adsorbent (MgO) were mixed at a difference ratio in SD technique. The dissolution of solvent was removed under hot air oven at 70°C for 30 min and dried under hot air oven at 40°C for 6-12 h. The samples were pulverized using mortar and pestle and the 0.05-0.25 mm particle size fractions were obtained by sieving.

Concentration of curcumin from TO (crude) and mixed sample were analyzed using a high performance liquid chromatography (HPLC, Shimadzu Scientific Instrument, MD, USA) with UV detector (SPD-10A), a pump (LC-10AD) and an automatic injector (SIL-10A). A sample in buffer solution was analyzed with the mobile phase consisting of methanol, 2% acetic acid and acetonitrile

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(23:36:41, v/v) at the flow rate of 1 mL/min. The wavelength of the UV detector was 420 nm and performed by isocratic separation using analytical column (Ultrasphere® C18). The samples were analyzed at a column temperature of 30°C. All experiments were determined in triplicates. Curcumin concentration and curcumin recovery were compared with the standard curcumin (Sigma grade).

Determination solubility of curcumin: Appropriate quantity of each sample was accurately weighed at 10 mg of curcumin from the TO (crude) and mixed sample and then transferred into a 10 mL volumetric flask. The samples were dissolved in 0.1 N hydrochloric acid dissolution and water. The paddles were rotated for 200 rpm at 5, 15, 30, 60 and 120 min with a magnetic stirrer at 37±0.5°C. The supernatants were filtered through a 0.2 µm millipore membrane filter at the same temperature. The aliquot of 20 µL was injected into the HPLC. Methanol, 2% acetic acid and acetonitrile (23:36:41, v/v) were used as mobile phase with UV detection set at 420 nm. All experiments were determined in triplicates.

Statistical analysis: Concentration, recovery and solubility of curcumin were compared with standard curcumin. Statistical analysis was performed using SAS for Windows (SAS, 2001). The differences among treatments were compared using Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

The mixture of TO, PEG400 and MgO were shown in Fig. 1. The crude TO had a black color similar in appearance to molasses. After added adsorbent, the color changed to dark brown. When higher dilutions of adsorbent were added, the color changed to dark yellow and light yellow, respectively. Turmeric oleoresin contains 17% curcumin. The curcumin concentrations in all fractions were approximately 2.7% (Table 2). The higher adsorbent [1, 2, 3 and 4 (w/w)] in the mixture sample had no effect on curcumin concentration ($p>0.05$).

The different fractions of adsorbent had an effect on curcumin recovery ($p<0.05$). The higher level of adsorbent increased the curcumin recovery. The highest curcumin recovery was found in crude curcumin followed by the curcumin from mixture at the ratio 1:1:3, 1:1:4, 1:1:2 and 1:1:1, respectively (Table 2). This was due to MgO acted as a protectant from substance disintegration between baking in SD technique (Leuner and Dressman, 2009).

The solubility of curcumin in various fractions of mixture samples in solution media consisted of water and 0.1 N hydrochloric acid compared with adsorbent (MgO) were shown in Fig. 2 and 3.

The concentration level of adsorbent had an influence on solubility of curcumin in the mixture sample. The higher solubility was observed from the higher level of adsorbent in 1:1:4 and 1:1:3 ratios in both of water and

Table 1: Fractions of Tumeric oleoresin (TO), carrier (Polyethylene glycol 400, PEG400) and adsorbent (Megnesium oxide, MgO) in solid dispersion technique (SD)

		---------- Weight (g) ----------		
Treatments	TO: PEG 400: MgO	TO	PEG400	MgO
0	1:0:0 (crude)	10	0	0
1	1:1:1 (SD)	10	10	10
2	1:1:2 (SD)	10	10	20
3	1:1:3 (SD)	10	10	30
4	1:1:4 (SD)	10	10	40

Fig. 1: Characteristic of mixture sample from the ratios of TO, PEG400 and MgO by solid dispersion (SD)

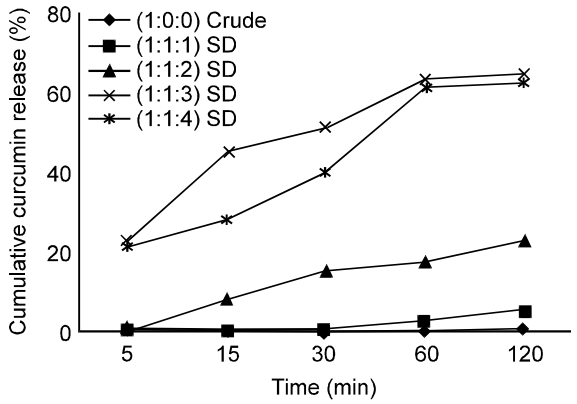

Fig. 2: Solubility profiles of curcumin solid dispersions (SD) with difference level of adsorbent in water

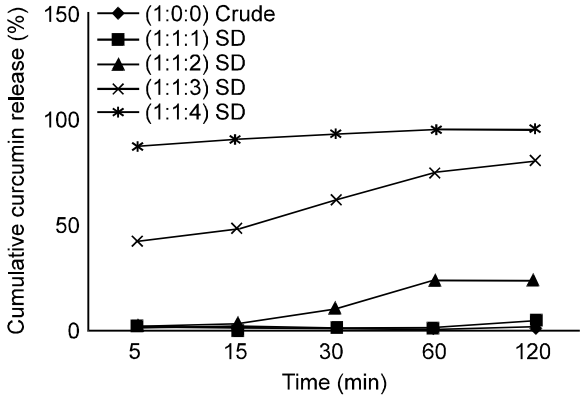

Fig. 3: Solubility profiles of curcumin solid dispersions (SD) with difference level of adsorbent in 0.1 N hydrochloric acid solution

Table 2: Concentration and curcumin recovery from the difference ratios of TO: PEG400: MgO

TO: PEG400: MgO	Curcumin, mg/100 mg (Mean±SEM)	Curcumin recovery (%) (Mean±SEM)
1:0:0 (crude)	1.7±0.01^{a}	99.98±0.92^{a}
1:1:1 (SD)	2.7±0.01^{b}	50.641±0.92^{e}
1:1:2 (SD)	2.7±0.01^{b}	68.59±0.92^{d}
1:1:3 (SD)	2.4±0.01^{b}	81.47±0.92^{b}
1:1:4 (SD)	2.2±0.01^{b}	76.32±0.92^{c}

^{abcde}Means within a column with different superscript letters are significantly different at p<0.05, SD = Solid dispersion, SEM = Standard error of mean

hydrochloric acid solution (p<0.05). It also increases surface of active carrier and solubility of the mixed sample. The carrier formed the soluble combination with curcumin and increased the wetting (Leuner and Dressman, 2009; Craig, 2002). The solubility enhancement of curcumin was influenced by an excellent wettability, which could be observed clearly from the solid dispersion as it rapidly left the surface and dispersed in the bulk of dissolution media (Tonnesen, 2002).

Conclusion: To increase the aqueous solubility of curcumin, the SD technique was employed by mix TO with hydrophilic carrier (PEG400) and absorbent (MgO) at different ratios. Ratios of 1:1:3 increased the solubility rate and recovery of curcumin more than the other ratios.

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REFERENCES

Craig, D.Q., 2002. The mechanisms of drug release from solid dispersion in water soluble polymer. Int. J. Pharm., 231: 131-144.

Khaled, K.A. and G.M. Mahrous, 2001. Comparative study of the dissolution and physicochemical characteristics of the binary systems of Quercetin with polyethylene glycol, polyvinyl pyrrolidone and hydroxyl propyl-beta-Cyclodextrin. Saudi Pharm. J., 9: 34-41.

Kochhar, K.P., 2008. Dietary spices in health and diseases (II). Indian. J. Physiol. Pharmacol., 52: 327-354.

Lefebvre, G., C.M, Brazier, H. Robert and A.M. Guyot-Hermann, 1985. Les Dispersions solides, pourquoi et comment. STP Pharma., 1: 300-22.

Leuner, C. and J. Dressman, 2009. Improving drug solubility for oral delivery using solid dispersion. Eur. J. Pharm. Biopharm., 50: 47-60.

Monique, J.V.O., M. Casteels, N. Warnants, L.V. Damme and C.V. Boucque, 1996. Omega-3 fatty acids in pig nutrition: Implications for the intrinsic and sensory quality of the meat. Meat Sci., 44: 55-63.

Ruderman, N.B., A.K. Saha, D. Vavvas and L.A. Witters, 1999. Malonyl-CoA, fuel sensing and insulin resistance. Anim. J. Physiol., 276: 1-18.

SAS (Statistical Analysis System), 2001. Statistical analysis system institute Inc., NC. USA.

Tonnesen, H.H., 2002. Solubility, chemical and photochemical stability of curcumin surfactant solutions. Pharmazie., 57: 820-824.