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Letter to Editor

PREPARATION OF FLAXSEED OIL EMULSIONS

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ABSTRACT

The purpose of this study was to prepare emulsions of flaxseed oil. The hydrophile-lipophile-balance value (HLB) of flaxseed oil was estimated from its fatty acid composition. This value was computed to be equal to 3.23. Emulsions were prepared with either Span 65 (HLB = 2.1) or Tween 40 (HLB = 15.6) at various concentrations ranging from 0.5% to 5%. The results indicated that overall, Span 65 produced better sedimentation volume value (F) than Tween 40 ($p < 0.0001$) however both emulsifiers produced similarly pharmaceutically acceptable F values at concentrations of 4% and 5%.

Key Words: Emulsion Preparation, Flaxseed Oil, Sedimentation Volume, Span 65, Tween 40

To the Editor, Flaxseed oil (*Linum usitatissimum*), also known as linseed oil, is a laxative and has anti-inflammatory properties.[1] The purpose of this study was to prepare a stable formulation of flaxseed oil emulsion. Administering flaxseed oil in the form of an emulsion would render it more palatable and better accepted by the user. The HLB value for flaxseed oil has not been reported before. For a perfectly hydrophobic substance, its HLB value is 0, and that for a perfectly hydrophilic substance the value is 20.[2] Flaxseed oil contains the following fatty acids (% content): α-linoleic (47.4%), linoleic (24.1%), oleic (19%), palmitic acid (6.5%), stearic (2.5%), arachidic (0.5%), eicosenoic (0.3%), and palmitoleic (0.25%).[3] Each of these acids had the same hydrophilic portion of 45 g (the weight of the carboxylate group 'COOH') but different lipophilic portion based on their molecular weight. Overall, the hydrophilic portion to the lipophilic portion was estimated to be 1:5.2 which resulted in a computed value for the hydrophilic portion to the total of 16.14%. Dividing this value by 5 yielded an estimated HLB value for flaxseed oil of 3.23 (Table 1). (The division by 5 allows the HLB value to be in the range of 0 to 20.)[2] The sedimentation volume (F; the ratio of the volume of the sedimented droplets to the total volume of the emulsion) was the indicator by which the emulsion's quality was determined. Higher F value would indicate a better formulation. Flaxseed oil emulsions were prepared using two different emulsifying agents, Span 65 (HLB = 2.1) or Tween 40 (HLB = 15.6) with varying concentrations of emulsifying agents (0.5%, 1%, 1.5%, 2%, 3%, 4%, and 5% v/v).[4] The emulsion was prepared by triturating 10 mL of flaxseed oil (Flax Oil: Organic, pure and unfiltered, freshly cold pressed, Barlean's Ferndale, WA) in 20 mL of distilled water in the presence of either Span 65 (Lot # BCBH3447V, CAS # 26658-19-5, Batch # 85547-250G, Sigma-Aldrich, Co. St. Louis, MO) or Polyoxyethylene Sorbitan Monopalmitate (Tween 40) (Lot # MKBF4940V, CAS # 26266-57-5, Batch # 388290-250G, Sigma-Aldrich, Co. St. Louis, MO) using a porcelain mortar. Butylated Hydroxytoluene (BHT, 1.77 mg) (Batch # W218405-1KG-K, Lot # MKBQ2103V, CAS # 128-37-0, Sigma-Aldrich, Co. St. Louis, MO) was added to the final mixture as an antioxidant, and the mixture was triturated well to reach a final uniform consistency for the emulsion. Three batches of emulsions were prepared with each of the emulsifying agents at the concentrations listed above. The emulsions were stored in a 100-mL plastic graduate cylinders at room temperature and kept in the dark [except when F reading was determined, the samples were exposed briefly (a few minutes) to florescent room light]. All preparations were kept covered with a laboratory plastic film to minimize water evaporation. The F value for the emulsions was determined at 1, 12, 24, 48, and 72 hours. Figure 1 shows the data for F obtained at 72 hours. A two-way analysis of variance test was used with F as the outcome and emulsifying agent type and their concentrations were the input variables. A *p* value of less than 5% was considered significant. Statistical analysis was done using JMP® Discovery Software (SAS Institute, Cary, NC). The results of this study showed that for most emulsions prepared, the sedimentation volume reached its ultimate value at 1 hour (data not shown). As the concentration of the emulsifying agent increased the F value also significantly improved ($p < 0.0001$). Overall, Span 65 produced better F value than Tween 40 ($p < 0.0001$) however both emulsifiers produced similarly pharmaceutically acceptable F values at concentrations of 4% and 5% (Figure 1). (The closer the F value to 1 the better is the emulsion.) All prepared emulsions of flaxseed oil must be dispensed in amber glass type bottles and stored at refrigerator temperature as the oil is unstable at room temperature and/or when exposed to light (undergoes oxidation).[5] (In this study, emulsions were kept at room temperature to accelerate the rate of settling as the study focused on the *physical* stability of the emulsion and not on the *chemical* stability of the oil.) Due to sedimentation upon storage, all emulsions must have a "shake well" auxiliary label affixed to the bottle to assure homogeneity of the delivered dose. In conclusion, both emulsifiers may be used in preparing stable flaxseed oil emulsions provided the concentration of the emulsifying agent used is at a minimum of 4%.

Table 1: HLB Value Calculation for Flaxseed Oil[2,3]

Acid	Lipophilic Part Weight	Hydrophilic Part Weight	Molecular Weight	Content (%)	Lipophilic Weight Contribution
Palmitic Acid	211.42	45	256.42	6.0	(211.42*6)/100 = 12.68
Stearic Acid	239.48	45	284.48	2.5	(239.48*2.5)/100 = 6.0
Arachidic Acid	259.47	45	304.47	0.5	(259.47*0.5)/100 = 1.3
Palmitoleic Acid	209.48	45	254.408	0.25	(209.48*0.25)/100 = 0.52
Oleic Acid	237.46	45	282.46	19.0	(237.46*19)/100 = 45.12
Eicosenoic Acid	265.51	45	310.51	0.3	(265.51*0.3)/100 = 0.80
Linoleic Acid	235.45	45	280.45	24.1	(235.45*24.1)/100 = 56.74
Alpha-Linoleic Acid	233.43	45	278.43	47.4	(233.43*47.4)/100 = 110.64
					Total = 233.8
Weight of Hydrophilic Portion (%) = {45/ (233.8+45)} x 100 = 16.14% HLB Value = [Weight of Hydrophilic Portion (%)]/5 = 16.14/5 = 3.23					

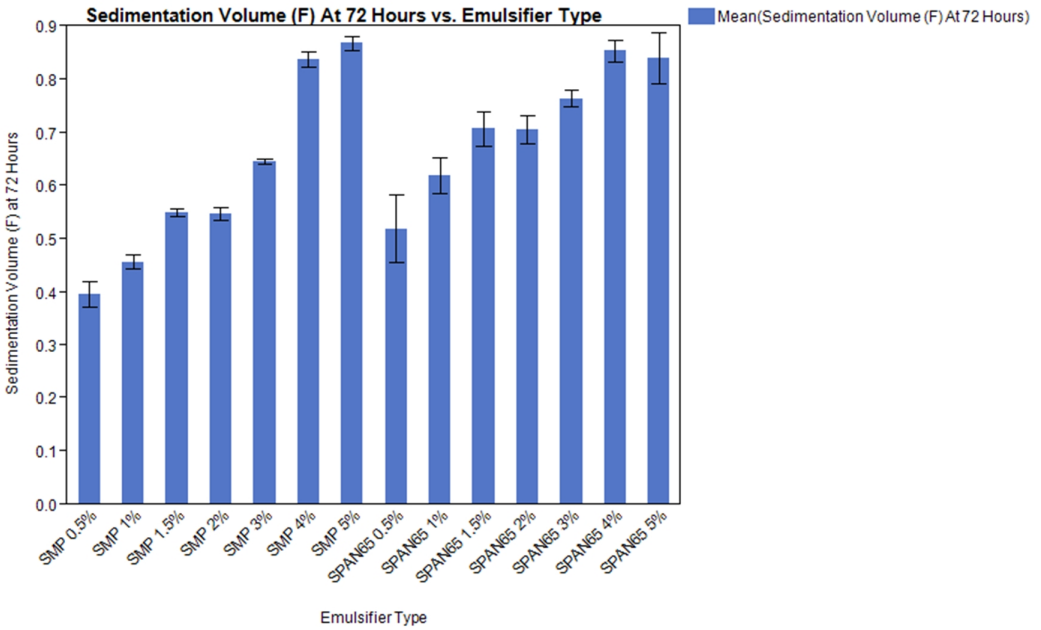

Figure 1. The sedimentation volume of emulsions prepared with Tween 40 [Sorbitan Monopalmitate (SMP)] or Span 65 various concentrations 0.5%, 1%, 1.5%, 2%, 3%, 4%, and 5%. Error bars are 1 standard deviation from the mean (n = 3).

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