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Cross-Validation of the Data Obtained for ω-6 Linoleic and ω-3 α-Linolenic Acids Concentration of Hemp Oil Using Jackknife and Bootstrap Resampling

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Abstract : Hemp (Cannabis sativa) possesses a rich content of ω-6 linoleic and ω-3 linolenic essential fatty acid in the ratio of 3:1, which is a rare and most desired ratio that enhances the quality of hemp oil. These components are beneficial for the development of cell and body growth, strengthen the immune system, possess anti-inflammatory action, lowering the risk of heart problem owing to its anti-clotting property and a remedy for arthritis and various disorders. The present study employs supercritical fluid extraction (SFE) approach on hemp seed at various conditions of parameters; temperature (40 - 80) °C, pressure (200 - 350) bar, flow rate (5 - 15) g/min, particle size (0.430 - 1.015) mm and amount of co-solvent (0 - 10) % of solvent flow rate through central composite design (CCD). CCD suggested 32 sets of experiments, which was carried out. As SFE process includes large number of variables, the present study recommends the application of resampling techniques for cross-validation of the obtained data. Cross-validation refits the model on each data to achieve the information regarding the error, variability, deviation etc. Bootstrap and jackknife are the most popular resampling techniques, which create a large number of data through resampling from the original dataset and analyze these data to check the validity of the obtained data. Jackknife resampling is based on the eliminating one observation from the original sample of size N without replacement. For jackknife resampling, the sample size is 31 (eliminating one observation), which is repeated by 32 times. Bootstrap is the frequently used statistical approach for estimating the sampling distribution of an estimator by resampling with replacement from the original sample. For bootstrap resampling, the sample size is 32, which was repeated by 100 times. Estimands for these resampling techniques are considered as mean, standard deviation, variation coefficient and standard error of the mean. For ω-6 linoleic acid concentration, mean value was approx. 58.5 for both resampling methods, which is the average (central value) of the sample mean of all data points. Similarly, for ω-3 linoleic acid concentration, mean was observed as 22.5 through both resampling. Variance exhibits the spread out of the data from its mean. Greater value of variance exhibits the large range of output data, which is 18 for ω-6 linoleic acid (ranging from 48.85 to 63.66 %) and 6 for ω-3 linoleic acid (ranging from 16.71 to 26.2 %). Further, low value of standard deviation (approx. 1 %), low standard error of the mean (< 0.8) and low variance coefficient (< 0.2) reflect the accuracy of the sample for prediction. All the estimator value of variance coefficients, standard deviation and standard error of the mean are found within the 95 % of confidence interval.

Keywords : resampling, supercritical fluid extraction, hemp oil, cross-validation
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