OPTIMISATION OF THE PROCESS PARAMETERS OF AN EXISTING CASHEW NUT SHELL OIL EXPELLER

BY

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ABSTRACT

The shell of the cashew nut in its natural state is leathery and contains thick vesicant oil called cashew nut shell liquid within a sponge-like interior. The oil has been known for its innumerable applications and its ability to undergo all the conventional reactions of phenols but the shell that contains the oil has always been used as fuel for burning. This study optimised an existing expeller by monitoring the process parameters used in assessing product quality. Design Expert 13 software package was used for analysis of variance and response surface optimisation. The central composite design in the response surface model was used at 2 levels of cashew varieties for the process parameters. A factorial experimental design was used at 3 levels of cashew sizes (small, medium and large), 3 levels of moisture content (14.5, 15.9 and 16.4% w.b.), 4 levels of wormshaft speed (30, 45, 60 and 75 rpm) and 2 levels of varieties (Ogbomoso and Brazilian) which were the process parameters considered. The study focused on the expeller response variables, which included its throughput, throughput efficiency, processing temperature, and the expeller oil qualities, such as free fatty acid, oil volatile impurities at 105°C, rancidity level, and acid value. The results showed that the optimum performance at maximum throughput, throughput efficiency, processing temperature, free fatty acid, oil volatile impurities at 105°C, rancidity level and acid value (Association of Official Analytical Chemists 2016 standard) were 0.226 and 0.279 kg/hr; 50.76 and 80.63%; 125.2 and 123.3°C; 1.84 and 2.02%m/m; 14.2 and 22.8%m/m; 5.1 and 7.04 Meq/kg; 0.3 and 0.14%m/m for Ogbomoso and Brazilian varieties, respectively. The optimum performance of the expeller at maximum throughput, throughput efficiency, wormshaft speed and moisture contents were 0.408 and 0.306 kg/hr; 91.68 and 86.02%; 30 and 35 rpm; 14.5 and 15.3% w.b. for Ogbomoso and Brazilian varieties, respectively. The interaction effect of process variables was significant ($p<0.05$) on oil

qualities, throughput and throughput efficiency for both Ogbomoso and Brazilian sizes. The generated regression models were suitable for predicting throughput, throughput efficiency and processing temperature based on the highest coefficient of determination (R^2) of 0.90-0.99, significant lack of fit (0.050-0.778) and models significance ($p<0.05$). The optimum conditions were heating temperatures of 130 and 70°C, heating durations of 5 minutes each, storage durations of 4 and 1 months, monitored average relative humidity of 58 and 56%, monitored average atmospheric temperatures of 32.2 and 31.2°C, free fatty acid of 1.84 and 2.02%m/m, oil volatile impurities at 105°C of 14.2 and 22.8%m/m, rancidity levels of 5.1 and 7.04 Meq/kg, acid value of 0.3 and 0.14%m/m with a desirability of 0.695 and 0.728 for Ogbomoso and Brazilian varieties, respectively. At the optimum conditions, the throughput of the expeller for Ogbomoso variety was 0.41 kg/hr, while the throughput efficiency of the expeller was 90% for Brazilian variety. The study revealed that sample size is the most significant factor for throughput and throughput efficiency of the oil expeller.