From the present study, the followings can be concluded:

*Moringa oleifera* (Drumstick) leaves were dried at 50, 60, 70 and 80°C at different air velocities 0.5 and 1.3 m/s air. The drying rate decreased continuously throughout the drying period. Constant rate period was absent and the drying process of drumstick leaves took place in falling rate period. Drying time decreased considerably with increased temperature and air velocity. Verma and logarithmic model was the best among the selected models for describing the drying behavior of drumstick leaves.

Drying rate or moisture loss rate was faster at the beginning of drying than that at the end. Drying rate decreases continuously with diminishing moisture ratio. The reduction in the drying rate at the end of drying is mainly due to reduction in moisture content as drying advances. Rate of migration of moisture from inner surface to outer surface decreases at the final stage of drying and hence lowers drying rates. Experimental results showed that drying air temperature and air velocity are effective parameters for the drying of drumstick leaves.

The effective moisture diffusivity ranged from 2.40 to $3.89 \times 10^{-9}$ m$^2$/s, when dried at 50 to 80°C at 0.5 m/s and $4.70 \times 10^{-9}$ to $1.50 \times 10^{-8}$ m$^2$/s at 1.3 m/s. The activation energy was calculated as 12.50 and 32.74 kJ/mol for drumstick leaves. Effective moisture diffusivity and activation energy increased with increase in temperature and air velocity. Dried leaves in the fabricated forced convective dryer when evaluated on the basis of color by sensory and L, a, b values, drying at 70°C
with an air velocity of 1.3 m/s was found to be the optimum in terms of energy efficiency and product quality.

Drumstick leaves were manually separated from the stems and were blanched at 80°C for 1-2 min in order to minimize the color losses. Then, drying was done in electric convective type dryer to develop the dehydrated product. The optimum drying conditions were 70°C (drying temperature) and 1.3 m/s (air velocity). The dried leaves were ground and sieved through a mesh size of 200 µm to form fine powder and packed in air tight polyethylene pouches until utilized. The moisture, crude fat, protein and ash content of dried drumstick leaves powder were 5, 2.4, 26.2 and 12.8%, respectively.

Replacement of wheat flour with DLP affected physical properties of sponge batter. Both viscosity and specific gravity increased with increase in replacement level of DLP and influenced sponge cake volume and textural properties. This might be due to increased uptake of water particularly by DLP fibers, which may reduce the amount of free water available and led to poor visco-elastic property.

The farinograph parameters, water absorption, dough development time, dough stability and mixing tolerance index varied in the range of 56.1–61.6%, 1.3–2.0 min, 3.3–2.1 min and 68-86 BU (Brabender units), respectively depending upon the level of incorporation of DLP. Water absorption, DDT and MTI increased significantly with increase in replacement level of wheat flour with the DLP whereas, dough stability decreased. However, no significant difference was observed at the replacement level of 2% DLP.

With increase in replacement level from 0–10%, the protein, crude fiber and ash content were increased significantly (SC10 > SC5 > SC2 > control) whereas, no significant difference was observed in moisture, fat and carbohydrate content. The
changes in the proximate composition were due to replacement of wheat flour with DLP. Also, there was significant increase in calcium, iron and β-carotene content with increasing replacement level from 0-10%.

No significant difference was observed in formulated sponge cake weight and water activity whereas, cake volume decreased significantly with increase in DLP replacement level in wheat flour, which was mainly affected by batter viscosity and specific gravity. Reduction in cake volume may be related to increased fiber content that weakens the gluten matrix and directly affected the retention of the air bubbles in baked sponge.

Results showed significant increase in hardness with replacement level. Sponge cake cohesiveness followed reverse trend of hardness, it decreases with increase in replacement level. Both springiness and resilience decreased with increasing the replacement level whereas, both gumminess and chewiness increased with increase in replacement level.

With increase in replacement level, DLP sponge cake nutritive value (calcium, iron and β-carotene) and bioactive properties (TPC, TFC and DPPH radical scavenging activity) were enhanced but, simultaneously reduced overall acceptability in terms of decreased volume, increased hardness, darker crust and crumb color and bitter flavor.

Sudden changes in specific gravity greater than 0.50 caused cracks in the structure of cake. DLP sponge cake prepared with 2% DLP finds good overall acceptability and showed competitive microstructure with control sample. All the formulated sponge cake samples were stable within safe limit of PV and TBA for a period of 15 days.
Moringa oleifera (PKM 1, variety) seeds contained 7.6% moisture, 33.1% crude oil, 37.8% crude proteins, 5.2% ash and 16.3% carbohydrate (by difference). Preliminary study indicated that the best suitable ranges for the extraction were 30-70% v/v, 40-80°C, 15-45 min and 0.5-0.75 mm for ethanol concentration, extraction temperature, extraction time and particle size respectively.

The optimum conditions for extraction of bioactive compounds were found as ethanol concentration, 49.8%; extraction temperature, 80°C; extraction time, 45 min and particle size, 0.62 mm. At optimum conditions, the experimental value for TPC, TFC, TAA, FRP and HPSA were 7.55 mg GAE/g, 517.87 mg CE/100 g, 5.51 mM AAE/g, 3.58 mM AAE/g and 5.75 mM TE/g, respectively which were reasonably close to the predicted value (7.39 mg GAE/g, 530.1 mg CE/100 g, 5.83 mM AAE/g, 3.22 mM AAE/g and 5.23 mM TE/g). Increase in temperature enhanced extraction efficiency. TPC, TAA and FRP increased with increase in time whereas, TFC and HPSA decreased with increase in time till 30 min then increased.

Bioactive compounds were identified using LC–MS technique, which led to an identification of 12 compounds. Major compounds were identified as 1H-pyrazol-4-yl-methanol, 1-(2-methyl-5-nitro-1H-imidazol-1-yl)propan-2-ol, 1,4-naphthoquinone, luteolin-6-c-glucoside and hesperidin. These compounds possess biological activities such as antioxidant, antimicrobial, anti-inflammatory, anti-fungal and anti-tumor.

Attempts have been made to standardize the processing conditions to encapsulate the drumstick oil with different carrier agents using spray drying technique. The combination of carrier agents and particle size had significant effect on EDOP characteristics. MD:GA emulsion were kinetically stable after 24 h whereas MD:WPC showed foam formation and small boundary layer separation. MD:GA
emulsions showed higher viscosity and smaller droplet size which resulted in stabilized emulsion and produced microcapsules with higher encapsulation efficiency and lower surface oil than MD:WPC microcapsules.

Microcapsules produced with MD:GA also exhibited lower span value, which helps to achieve better flowability due to lower width distribution of microcapsules. EDOP with MD:GA were more denser particles as compared to MD:WPC. EDOP with higher bulk density (MD:GA) occluded less air in the spaces between particles, which reduces the lipid oxidation and hence increased the storage stability.

Microstructure of MD:GA microcapsules showed smooth surface with continuous wall, having no cracks and no agglomerates, which signified that microparticles are lesser permeable to gases. The combination of MD:GA proved to be desirable carrier agent with higher encapsulation efficiency along with lower moisture content and water activity by protecting active core ingredient against environmental conditions.

Higher surface oil of MD:WPC microcapsules lead to the higher rate of oxidation, as WPC micro particles are mostly shrinked, shriveled and have dents, which causes higher susceptibility to oxidation and lower retention of active material. Data revealed that MD:GA can be efficiently used for encapsulating drumstick oil, which can be further utilized as a functional food ingredient.

Unlike spray drying, freeze drying is also used for increasing stability of oils that prevents deterioration of food substance. Efforts have been made to examine the comparative behavior of drumstick oil microcapsules, obtained from freeze drying (FD) and spray drying (SD) techniques. Microcapsules characteristics and oxidative stability was greatly influenced by the type of drying method used for encapsulating the active core material.
Spray dried microcapsules showed higher encapsulation efficiency and lesser surface oil along with lesser cohesive index and caking strength. Encapsulation efficiency obtained by spray drying microcapsule was 91.05% and was comparatively higher as compared to freeze drying method, 67.72%. The difference in encapsulation efficiency might be due to the difference in dehydration mechanism, which largely affects the EDOP wall integrity and microstructure and thus, enhances the retention of active core material.

Spray drying technique was more efficient in minimizing final moisture content of material than freeze drying. Spray dried EDOP showed lower moisture content that may be due to large surface area available during atomization that enhances the rate of heat transfer and thus reduces the moisture content. The drying method used for encapsulation significantly affected the EDOP bulk density. Spray dried EDOP showed higher bulk density than freeze dried EDOP.

Spray dried microcapsules depicts smooth spherical shape microparticles, while freeze dried microcapsules had non-spherical porous flake like particles. Morphological analysis confirms the higher encapsulation efficiency and oxidative stability of spray dried EDOP. Thermal decomposition temperature range and residue percent of spray dried microcapsules was higher as compared to freeze dried microcapsules, indicating better thermal stability.

Both spray and freeze dried EDOPs (encapsulated drumstick oil powder) showed the similar FT-IR spectrum. Besides peak intensity and the presence of carrier agents in the spectrum of EDOPs from spray and freeze drying, remaining spectrum appears similar, which confirms the compatibility of core material with carrier agents.
Spray dried microcapsules showed better oxidative stability as compared to the freeze dried. Therefore, spray drying acts as a promising drying technique used for encapsulating drumstick oil for its utilization as a functional food ingredient.