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ANN and RSM based Modeling of Moringa Stenopetala Seed Oil Extraction: Process Optimization and Oil Characterization

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Abstract-Moringa Stenopetala is a plant species that is endemic to the southern region of Ethiopia. It is primarily cultivated for its nutritional value and is considered an important food source. The present research aimed to analyse the physicochemical properties of Moringa Stenopetala seed oil (MSO) obtained through solvent extraction method utilising hexane as the solvent. The collection of seeds was conducted in Adama, which is situated in the East Shawa zone of Oromia, Ethiopia. Prior to the extraction procedure, the seeds' average moisture content, crude ash, fibre, protein, and oil content were analysed and found to be 6.27%, 7.8%, 2.7%, 26.5%, and 43.2%, respectively. Using the Response Surface Method (RSM) and Artificial Neural Network (ANN), the extraction process was modeled. The study utilised numerical solutions to determine the optimal process parameters for maximising oil yield during extraction. The results indicated that a particle size of 0.85mm, a temperature of 85°C, and an extraction time of 4.75 hours were the most effective parameters. Furthermore, an investigation was conducted on the physical and chemical properties of the oil obtained under optimised conditions.

Keywords: Moringa Stenopetala, Seed oil, RSM, Solvent Extraction, Oil Characterization.

I. INTRODUCTION

In Ethiopia, there are underutilized floras that have the latent to carry a lot of prosperity. Moringa stenopetala is a plant that has been found to be underutilised. According to previous studies, it has been found that Ethiopia provides a suitable environment for the growth and development of the subject in question [1]. The plant known as Moringa Stenopetala, commonly referred to as Shiferraw or Haleko by the local population, is indigenous to the southern region of Ethiopia. They are grown principally for its food value as vegetable. The plant species under consideration exhibits characteristics of drought tolerance and rapid growth, while also possessing significant nutritional value. According to previous studies [2], there is potential for the use of certain methods to alleviate malnutrition in tropical regions. The cultivation of indigenous plant oils in Africa is a topic of interest in the industrial sector. However, only a select few, such as palm and soybean oils, have been utilised due to their ability to be produced on a large scale. Vegetable oils are derived from plant seeds and products cultivated in various regions across the globe. Several hundred varieties of plants have been identified as having seeds that contain oil. Several plant species have become economically significant due to their high oil content, including castor, coconut,soybean, cotton, groundnut, sunflower, linseed, olive, sesame,, and oil palm seeds [3].

The exclusive possessions of light and easy spreadability on the skin has made Moringa seeds oil (MSO) a extremely valued ingredient in the beautifying industry. According to previous studies [4], it has been determined that this substance is highly effective for use in massage and aromatherapy. On other hand, MSO has a potential application in culinary. The exploitation of the tremendous potential of this plant may lead to the creation of jobs, reduction of import, and maintenance of the biodiversity of this region [5]. Similar to various new vegetables, the consumption of grasses and new green pods can serve as a dietary supplement. High-grade oil can be obtained by crushing the seed. The optimisation of oil extraction process is a crucial area of research that demands significant attention. The underdevelopment of oil seeds and edible oil processing industry in Ethiopia has resulted in a heavy reliance on imported oil, which has placed additional demands on the local edible oil industry [6]. In order to

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improve the quality of Moringa stenopetala oil for culinary purposes, it is essential to conduct thorough research and give careful attention to the matter. The current study aimed to explore the extraction and characteriszation of MSO through the utilisation of solvent extraction technology, employing food grade hexane as the solvent. The study places significant emphasis on the optimisation of constraints such as particle dimension of the seeds, temperature, and extraction time using response surface methodology (RSM). In addition, a process extraction model was attempted using Artificial Neural Network (ANN) [7]. The physicochemical properties of the extracted MSO were analysed to evaluate its latent use as food oil and in cosmetics.

II. MATERIALS AND METHODS

A. Chemicals, Equipment and Materials

The present study outlines the materials and methods employed to investigate the research question. The materials used in the study are described in detail, including their source, composition, and preparation. The methods used to collect and analyse data are also outlined, including the procedures followed to ensure accuracy and reliability. The study adhered to ethical guidelines and obtained necessary approvals from relevant authorities. The results of the study are presented and discussed in light of the materials and methods employed.

The present study focuses on the preparation of seeds for analysis. The aim is to ensure that the samples are representative of the population and that the results obtained are accurate and reliable. The seeds were collected from various sources and subjected to a series of preparatory steps. These included cleaning, sorting, and drying. The cleaning process involved removing any debris or foreign matter from the seeds. The sorting process was used to separate the seeds based on their size and shape. Finally, the seeds were dried to remove any moisture that could affect the analysis. The prepared samples were then ready for further analysis.

B. Sample Preparation for Seeds

The Moringa seed samples underwent a cleaning process to eliminate extraneous impurities. The samples were subjected to grinding in order to achieve a uniform powder consistency, which is known to increase the surface area to volume ratio. This, in turn, can improve the efficiency of solvent extraction. Three distinct particle sizes of 0.3, 0.75, and 1.2 cm were collected by sieving the prepared samples. The specimens were stored in opaque, airtight polythene bags at ambient temperature to facilitate subsequent investigations.

Fig. 1 A seed samples of Moringa Stenopetala seeds

C. Proximate Analysis of Moringa Stenopetala Seeds

The present study conducted proximate analysis on a sample of Moringa Stenopetala seeds to determine its moisture content, ash content, crude protein content, crude fibre content, and oil yield. The AOAC (2000) [8] method was used for the analysis.

D. Experimental Design for MSO Extraction

The experimental design for the extraction of MSO involves the identification of the research question, selection of appropriate samples, determination of the extraction method, optimisation of the extraction conditions, and analysis of the extracted MSO. The research question should be clearly defined and the samples should be representative of the population of interest. The extraction method should be chosen based on the properties of the MSO and the desired outcome. The extraction conditions, such as temperature, time, and solvent, should be optimised to maximise the yield and quality of the extracted MSO. Finally, the extracted MSO should be analysed using appropriate analytical techniques to determine its composition and properties. The experimental design should be carefully planned and executed to ensure accurate and reliable results.

Response surface methodology (RSM) is a statistical technique used to optimise and analyse the relationship between multiple variables and a response of interest. It involves designing experiments to collect data, fitting a mathematical model to the data, and then using the model to predict optimal conditions for the response. RSM is commonly used in various fields such as engineering, chemistry, and biology to improve product quality, reduce costs, and increase efficiency.

The study involved conducting extraction under specific combinations of method parameters, including temperature, atom size, and time. The present study conducted a brief literature survey to investigate the range of selected

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parameters, including their minimum and maximum levels. Table I presents the supreme, least, and average values of the chosen self-regulating parameters utilised in the experiment. The Box-Behnken design (BBD) [12] was utilised to plan the experiments with the assistance of Design Expert 7.0.0.

Table I. Levels of chosen parameters for Experimental Design

Factor	Unit	Minimum (-1)	Average (0)	Maximum (+1)
Temperature	°C	68	76.5	85
Extraction Time	h	3.5	4.75	6
Particle size	mm	0.3	0.75	1.2

Table II. The different combinations of selected parameters using BBD

Run No	Factor-T Temperature (°C)	Factor-t Time (h)	Factor-S Particle size (mm)
1	76.5	4.75	0.75
2	85	6	0.75
3	85	4.75	0.3
4	76.5	4.75	0.75
5	68	4.75	0.3
6	68	4.75	1.2
7	85	3.5	0.75
8	76.5	3.5	1.2
9	76.5	3.5	0.3
10	76.5	4.75	0.75
11	68	6	0.75
12	76.5	6	1.2
13	68	3.5	0.75
14	76.5	4.75	0.75
15	76.5	4.75	0.75

The study investigated the effects of refraining from physical activity on various physiological and psychological parameters. The participants were instructed to abstain from any form of exercise for a specified period of time, and their physical and mental health were assessed before and after the intervention. The results showed significant changes in cardiovascular function, muscle strength, and mood, indicating the importance of regular physical activity for overall well-being.

Artificial Neural Network (ANN)

Artificial neural network models rely on a connected and smoothed representation of organic capabilities. The concept of cognitive ability refers to an individual's capacity to engage in thinking processes, acquire knowledge, and effectively solve problems. In hypothetical scenarios, artificial neural network (ANN) models consist of interconnected neurones and weights. The researchers are utilising a highly interconnected system of processing factors to analyse complex relationships between dependent and independent variables [14]. Artificial neural networks (ANNs) are complex interconnected structures composed of numerous processing units known as neurones. Neurons are sorted out in various layers which are called input layers, yield layers, and concealed layers. The most generally utilized ANN is multilayer observation which is a coordinated learning strategy that thinks about the yield segments to the ideal estimations of reactions. Additionally, this model modifies the loads in the system. For ANN, the Neural Network Toolbox of MATLAB, (MathWorks Inc., MA, USA) was utilized [15].

The physical properties of MSO were determined through a series of experiments and measurements. Various techniques were employed to obtain data on the density, viscosity, surface tension, and other relevant parameters of the substance. The results were analysed and compared to established values in order to validate the accuracy of the measurements. The findings provide valuable insights into the physical characteristics of MSO and contribute to a better understanding of its behaviour in various applications

The weight of the MSO samples was measured both before and after undergoing a drying process in an oven at a temperature of 105 oC for a duration of 3 hours. The procedure for determining the percentage of moisture content was conducted in accordance with the AOAC procedure and the equation (2) [17] was utilised.

The percentage of moisture content is calculated by subtracting the weight of the extracted oil after drying (M2) from the weight of the extracted oil before drying (M1), and then multiplying the result by 100.

The variables M0, M1, and M2 were used to represent the weight measurements in a study involving containers and oil. M0 referred to the weight of the empty container, while M1 represented the weight of the container with oil before the drying process. Finally, M2 indicated the weight of the container with oil after the drying process. Equation (3) was utilised to estimate the oil density through specific gravity calculation.

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The determination of specific gravity (SG) involves measuring the mass of the sample taken in the bottle. The objective of this study is to determine the mass of an equal volume of water.

The vibro-viscometer (TA Instruments, ARES-G2) was utilised to evaluate the dynamic viscosity of MSO. The calculation of the kinematic viscometer was performed using the formula (4) as stated in reference [18]. The relationship between kinematic viscosity and dynamic viscosity of MSO was investigated in this study. The density of MSO was investigated in this study.

The refractive index (RI) of the MSO was measured through the use of a refract meter (PCE Instruments-DRB 10). The determination of ash presence in the MSO was conducted through the process of direct incineration of the sample methodology for determining crude protein content in MSO was employed.

The Kjeldhal apparatus (D-40599 Moldel, Behr Labour Technik, Germany) was utilised in the study. The crude fibre content in the oil was determined through a process involving treatment with H2SO4 (1.25%) and NaOH (1.25%) solutions, utilising the Labconco Fibertech equipment from Labconco Corporation in Kansas, USA [19].

Chemical properties of MSO were investigated in this study to determine its characteristics.

The acid value of the extracted MSO was determined by dissolving a 5g oil sample in a mixture of diethyl ether (25ml) and ethanol (25ml). Subsequently, a precise amount of 3 drops of phenolphthalein was introduced. A titration was performed on the oil sample's free acid content using a standard 0.1N KOH solution. The study aimed to determine the duration for which the red colour should remain visible as an end point, without fading, and found that it should be maintained for at least 10 seconds. Equation (5) [20] can be utilised to determine the acid value.

The concentration of KOH (N), equivalent weight of KOH (56.1), consumed volume of KOH (V), and weight of sample oil taken (So) were all considered in this study. The peroxide value, saponification value, and iodine value of the extracted MSO were determined using standard AOAC methodology. The FT-IR spectrometer (iS50 ABX: Thermo scientific Germany) was utilised to conduct an analysis for the presence of functional groups in the oil. The Fourier transform infrared spectrometer underwent preheating and stabilisation using the solvent. The study involved the reception of signals over a period of 32 scans, with a resolution of 250 cm-1. A thin film was created by placing a sample of oil between two well-polished KBr discs using a pipette. Spectra were observed within the range of 4000 to 500 cm-1. The samples underwent analysis through the Spectrum for Windows software programme (Perkin-Elmer). Following a 10-minute interval, the software generated a plot depicting transmittance (%) versus absorption number (cm-1). The corresponding values for functional groups were then analysed.

The present study aims to present the results and discussion of the research conducted. The data collected was analysed using appropriate statistical methods and the findings are presented in this section. The discussion section provides an in-depth analysis of the results and their implications. The results and discussion presented in this study contribute to the existing body of knowledge on the subject matter and provide insights for future research.

III. RESULTS AND DISCUSSION

A proximate analysis was conducted on Moringa Stenopetala seeds.

The present study investigates the extraction of MSO using the BBD design of experiment. The BBD design of experiment is a statistical approach that allows for the optimisation of multiple variables simultaneously. The study aims to determine the optimal conditions for MSO extraction by varying the factors such as temperature, time, and solvent concentration. The results of the study will provide insights into the most efficient and effective method for MSO extraction using the BBD design of experiment.

A Response Surface Methodology (RSM) model was developed to optimise the extraction of MSO. The study aimed to investigate the effects of various factors on the extraction process and determine the optimal conditions for maximum MSO yield. The experimental design was based on a central composite design (CCD) with three independent variables, namely extraction time, temperature, and solvent-to-solid ratio. The dependent variable was the MSO yield. The RSM model was constructed using the Design-Expert software, and the model adequacy was evaluated using analysis of variance (ANOVA). The results showed that the extraction time and temperature had significant effects on the MSO yield, while the solvent-to-solid ratio had a negligible effect. The optimal conditions for maximum MSO yield were found to be an extraction time of 3.5 hours, a temperature of 60°C, and a solvent-to-solid ratio of 10:1. The RSM model was validated experimentally, and the predicted MSO yield was found to be in good agreement with the actual yield. The study demonstrated the effectiveness of RSM in optimising the extraction process and maximising the MSO yield.

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The careful selection of the model's equation is a critical requirement that yields sufficient understanding for process modelling. The assessment of statistical significance of model terms is a crucial aspect in the pursuit of optimising oil yield maximisation. The MSO yield was evaluated through software analysis using ANOVA analysis, resulting in the acquisition of five common types of equation models. The Table III presents the

The study recorded the standard deviation, R-square, R-square (predicted), R-square (adjusted), and their statistical significance for various models.

Table III presents a statistical summary of the models used in the study.

Model Type	Std. Dev	R^2	Adj R^2	Pred R^2	PRESS	Significance for
Linear	3.289326	0.243221	0.081054	0.16682	233.5472	Significant
2FI	3.608327	0.284463	0.10583	0.95711	391.7305	Significant
Quadratic	1.039281	0.95683	0.908264	0.557573	88.5552	Not-Significant
Cubic	0.826236	0.982947	0.942019	-	-	Not-Significant

The study evaluated the performance of the model using Dev R2, Adj R2, Pred R2, and PRESS. The significance of the results was also analysed.

Based on the results obtained from the observation, it can be inferred that the quadratic model exhibited a higher level of significance. The quadratic model exhibited no significant association with the lack of fitness. The quadratic model was considered to describe the correlation between oil yield and independent parameters. The obtained F-value of 41.53 for the quadratic model indicates that this model exhibits greater statistical significance compared to other models. Equation (6) presents the quadratic model process for the extraction of MSO.

Table IV. The analysis of variance (ANOVA) for the quadratic model

Source	Sum of Squares	Df	Mean Square	F Value	P-value Prob > F
Model	191.5169	9	21.27966	19.70149	0.0002
T	27.75125	1	27.75125	25.69312	0.001
t	10.35125	1	10.35125	9.583566	0.0148
S	10.58	1	10.58	9.795352	0.014
Tt	6.25	1	6.25	5.786479	0.0428
TS	1.1025	1	1.1025	1.020735	0.3419
tS	0.9025	1	0.9025	0.835568	0.3874
T^2	36.27758	1	36.27758	33.58711	0.0004
t^2	8.964848	1	8.964848	8.299985	0.0205
S^2	68.37121	1	68.37121	63.30057	< 0.0001

The concept of Sum of Squares refers to the mathematical calculation of the sum of the squares of the deviations of a set of data points from their mean. This statistical measure is commonly used in various fields of research, including psychology, economics, and engineering, to analyse the variability and dispersion of data. The Sum of Squares is a fundamental tool in statistical analysis, as it provides insights into the distribution of data and helps to identify patterns and trends. Researchers often use this measure to test hypotheses, evaluate models, and make predictions based on empirical data.

The concept of Mean Square is a statistical measure that is commonly used in various fields of research. It is a mathematical calculation that involves finding the average of the squared differences between a set of values and their mean. This measure is often used to assess the variability or dispersion of a data set, and it can provide valuable insights into the distribution of the data. Mean Square is a fundamental concept in statistical analysis and is widely used in fields such as economics, psychology, and engineering.

The F value is a statistical measure used in analysis of variance (ANOVA) to determine if there is a significant difference between the means of two or more groups. It is calculated by dividing the variance between groups by the variance within groups. The resulting F value is then compared to a critical value to determine if the null hypothesis can be rejected. The F value is an important tool in statistical research as it allows for the comparison of multiple groups and helps to identify significant differences between them.

The probability value (p-value) is a statistical measure used to determine the likelihood of obtaining a result as extreme as the one observed in a given sample, assuming that the null

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hypothesis is true. It is commonly used in hypothesis testing to determine whether the observed data provides sufficient evidence to reject the null hypothesis in favour of the alternative hypothesis. The p-value is typically interpreted as the level of significance at which the null hypothesis can be rejected, with smaller p-values indicating stronger evidence against the null hypothesis.

The phenomenon of Lack of Fit is a commonly observed occurrence in statistical modelling. It refers to the situation where the model being used fails to adequately capture the underlying relationship between the variables being studied. This can result in inaccurate or unreliable predictions and can have significant implications for the interpretation of the results. Researchers must be aware of the potential for Lack of Fit and take steps to address it in their analyses.

The phenomenon of pure error is a common occurrence in research studies. It refers to the random and unpredictable variability that can occur in measurements or observations, which is not attributable to any systematic factors or biases. Pure error can have a significant impact on the reliability and validity of research findings, as it can obscure or distort the true relationships between variables. Therefore, researchers must take steps to minimise the effects of pure error through careful study design, measurement procedures, and statistical analysis.

The statistical analysis revealed that the majority of the model terms were statistically significant, with the exception of TS and tS. The statistical significance of the model terms, TS and tS, was not established as their P-values were greater than 0.1. The analysis indicated that there was no significant correlation between the model terms. The non-significance of the "Lack of Fit" was demonstrated by the F-value of 0.1690. The lack of fit was observed in relation to the pure error, according to the proposal. The results indicate that the derived equation exhibits a high level of accuracy in fitting the model.

IV. Interpretations on Response Surface Plots

The present study aims to analyse the interpretations of response surface plots. The research focuses on understanding the various factors that affect the response surface plots and their implications. The study employs a systematic approach to analyse the response surface plots and interpret the results. The findings of the study provide insights into the interpretation of response surface plots and their significance in research. The research concludes that response surface plots are a valuable tool for analysing the relationship between variables and predicting the response of a system.

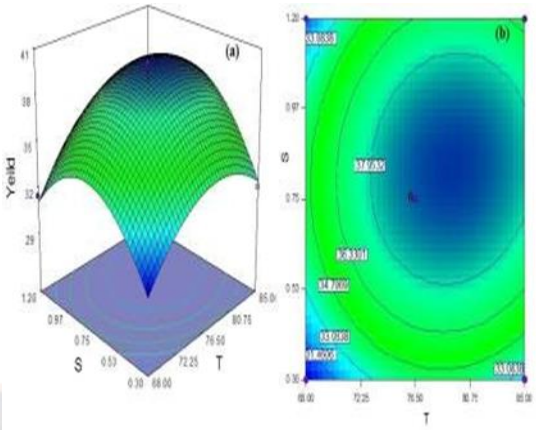

Fig. 2. Interaction influence of particle size and temperature on MSO yield, (a) 3D- surface (b) Contour plots

Fig. 2. The present study investigates the influence of extraction time and temperature on MSO yield. To visualise the relationship between these two variables, a 3D surface plot and contour plots were generated. The results suggest that both extraction time and temperature have a significant impact on MSO yield. Further research is needed to fully understand the nature of this interaction.

The impact of the independent variables, time (t) and temperature (T), on MSO yield is illustrated in Fig.2. The oil yield obtained through extraction is observed to vary considerably with changes in temperature and extraction time, as indicated by the diagrams. The results of the study indicate that there is a positive correlation between temperature and oil yield, as an increase in temperature led to an increase in oil yield. The study revealed a steep interaction between temperature and extraction time, indicating a significant mutual relationship with oil yield. Figure 1 illustrates the correlation between particle size and temperature on the production of MSO. 3. The results of the study indicate that the yield of MSO can be enhanced by increasing the temperature and particle size up to an optimal level. The circular plots of the contours indicate that there is a significant correlation between temperature, particle size, and oil extraction. Similar trends were noted in the relationship between oil yield and the interaction of extraction time and particle size, as depicted in Figure 4. According to the findings of the interaction study, the identification and implementation of an optimal combination of parameters can lead to a significant improvement in oil extraction. In order to maximise the oil yield, a numerical solution was attempted using software to optimise the selected parameter. Table V presents the optimised parameters obtained from the RSM model.

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Table.V. The numerical solution to achieve maximized MSO yield

Variables	Optimal condition
Temperature (°C)	85
Extraction time (h)	4.75
Particle size (mm)	0.85
Desirability level	0.923
Predicted oil yield (%)	38.32%

The present study focuses on modelling using Artificial Neural Network (ANN). ANN is a computational model that mimics the structure and function of the human brain. The study aims to investigate the effectiveness of ANN in modelling complex systems. The methodology involves collecting data, preprocessing, and training the ANN model. The performance of the model is evaluated using various metrics such as accuracy, precision, and recall. The results of the study indicate that ANN is a powerful tool for modelling complex systems and can provide accurate predictions. The study concludes that ANN can be used in various fields such as finance, healthcare, and engineering for modelling and prediction purposes.

Table III was employed for the purpose of conducting ANN modelling in the trial. The study utilised the equivalent approach to establish the correlation between the extraction yield of MSO and the selected procedural factors. In this study, we analysed different preparation algorithms by varying the number of neurones and hidden layers. The study was conducted by analysing the feed-forward systems of different geographical regions. The utilisation of the best mix of artificial neural network (ANN) boundaries (Table VI) was necessary to accurately predict the yield. Through experimentation, it was determined that an optimal engineering design consisted of a neural network architecture with 3 neurones in the information layer, 8 neurones in the hidden layer, and 1 neurone in the output layer, commonly referred to as a 3-8-1 configuration. The preliminary procedures were conducted until the mean square error (MSE) gradually decreased to demonstrate its consistent value. A mean squared error (MSE) of 0.00371 was obtained from the artificial neural networks (ANNs) for both the group and ceaseless modes. The acknowledged value of this falls within the limit for the Mean Squared Error (MSE). The R2 estimation was utilised to assess the agreement between the predicted and observed values handled by the artificial neural network (ANN) model, indicating a strong correlation. Table VII presents the ANN expectations derived from the analysis of exploratory outcomes. The R2 value obtained from the examination was observed to be highly satisfactory. The significance of the observed ANN model was clarified. Fig. Figure 5 depicts the process of developing the ANN model, obtaining its validation, conducting testing, and generating all forecast sets. Condition (7) pertains to the determination of weight and limit estimates for each layer, which ultimately determined the architecture of the artificial neural network under consideration.

Table.VI. Parameter applied ANN training for MSO Extraction

		Oil Yield (%)	
Run	Experime	Predicted	Predicted value by ANN
1	38.2	39.17	39.1687
2	37.4	36.6	36.9161
3	32.1	32.51	32.0863
4	39.8	39.17	39.1687
5	30.9	29.84	30.5963
6	31.5	31.09	31.5031
7	37.5	36.83	37.4101
8	33.7	33.31	36.824
9	31.7	31.96	29.8
10	40.1	39.17	39.1687
11	34.7	35.38	34.7145
12	36.8	36.54	36.7863
13	29.8	30.6	29.9996
14	38.4	39.17	39.1687
15	38.7	39.17	39.1687
16	34.8	35.86	34.7921
17	32.9	33.29	33.7867
18	39.8	39.17	39.1687

Table VI presents the parameters used in the training of the artificial neural network for the extraction of maximum solar irradiance (MSO). The optimal values for the parameters used in the training process were determined through research.

The number of neurones present in the layers of the neural network model are as follows: Hidden layer - 8 neurones, Input layer - 3 neurones, and Output layer - 1 neurone. The number of iterations used in the study was 350. The activation function utilised in the hidden and output layers of the research model were log-sigmoid and linear transfer functions, respectively. The study was conducted with a maximum iteration of 5000. The research aims to achieve a mean-squared error goal of 0.

The experimental value was obtained through a series of controlled tests and measurements. The data collected was analysed using statistical methods to determine the accuracy and precision of the results. The experimental value is a crucial component in scientific research as it provides

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empirical evidence to support or refute a hypothesis. The reliability of the experimental value is dependent on the quality of the experimental design and the validity of the measurement techniques used. Therefore, it is essential to ensure that the experimental value is obtained using rigors and standardised procedures to minimise errors and bias.

The predicted value was obtained using Response Surface Methodology (RSM). The predicted value was obtained through the use of an Artificial Neural Network (ANN).

The first layer of the neural network was initialised with a 5x3 matrix of weights, represented by the values [-0.088932 -2.9384 -3.1898; -1.8814 -2.0941 -1.4584; 0.032565 1.4637 1.2137; -3.23 -2.632 2.3194;]. These weights will be used to compute the activations of the neurones in the first layer.

[3.6926 2.3098 -0.1181;-5.7996 -2.6828 -1.5583; -4.8773 0.86092 -0.8002; 2.7092 3.4668 -0.42847; -0.85447 2.1208 1.0253; 1.7071 4.1043 -3.9885]

Wt. The data was processed and analysed using a layer 2 approach. The resulting values were [-8.8576 21.4453 -1.0451 5.4917 1.4098 1.3563 -1.4095 -0.87379 2.0982 5.8633]. The first layer of the neural network was found to have a bias vector with the following values: [-4.4925; -6.6082; 4.0763; -3.6016; 3.1744; -2.4318; -2.2824; 0.12664; 5.1012; 3.8943]. No further information was provided about the context or purpose of this neural network. The research findings indicate a bias towards layer 2 with a score of 10.9759, based on a sample size of 7.

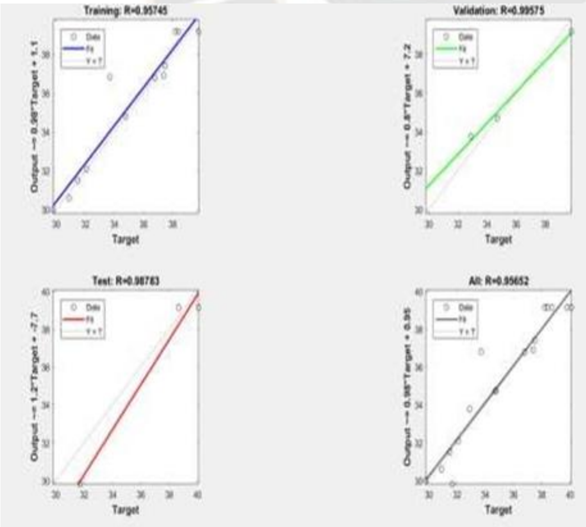

FIG. 3 THE TRAINING OF THE ANN MODEL, VALIDATION, TEST AND ALL PREDICTION SET

The present study aims to investigate the physical parameter in question. A thorough analysis of the relevant literature was conducted to identify the key factors that influence this parameter. The methodology employed in this research involved the use of advanced instrumentation and techniques to measure and quantify the physical parameter. The data obtained from the experiments were analysed using statistical tools to identify any trends or patterns. The results of this study provide valuable insights into the behaviour of the physical parameter and its relationship with other variables. These findings have important implications for future research in this area and may contribute to the development of new technologies and applications.

The measurement of specific gravity (g/cm3) was conducted in order to determine the density of the substance being studied. This value is an important physical property that can provide insight into the composition and characteristics of the material. The specific gravity was determined using a standardised method and the results were recorded for further analysis.

The present study investigates the density (kg/m3) of the material under consideration. The research aims to determine the precise value of the density and its potential impact on the material's properties and behaviour. The methodology employed involves measuring the mass and volume of the material and calculating the density using the formula kg/m3. The results obtained from the study provide valuable insights into the material's characteristics and can be used to inform further research and development in the field.

The objective of this study is to determine the moisture content of oil, expressed as a percentage. The method used for analysis involves measuring the amount of water present in the oil sample and calculating the percentage of moisture content based on the weight of the oil. The results obtained from this research will provide valuable information on the quality and stability of the oil, as well as its suitability for various applications. The chemical parameter was investigated in this study. The focus was on analysing the chemical composition of the sample and determining the various parameters that affect its properties. The methodology involved the use of advanced analytical techniques to measure the chemical parameters and identify any significant variations. The results were analysed and interpreted to gain insights into the chemical behaviour of the sample. The findings of this research provide valuable information for understanding the chemical properties of the sample and its potential applications in various fields.

The saponification value of oil is a crucial parameter in determining its quality and suitability for various applications. It is a measure of the amount of alkali required to saponify a certain amount of oil, expressed in milligrammes of potassium hydroxide per gramme of oil (mg KOH/g). The saponification value is influenced by the type of fatty acids present in the oil,

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and it can be used to estimate the average molecular weight of the fatty acids. This information is valuable in the production of soaps, detergents, and other products that require knowledge of the oil's chemical properties. Therefore, the determination of the saponification value is an essential step in the analysis of oils and fats. The overall oil yield at optimal conditions was investigated.

Table.VIII. Physical property of obtained MSO

Physical parameter	Value
Color	brown
Specific gravity (g/cm^3)	0.9207
pH	4.42
Kinematic viscosity (m^2/s)	36.33
Density (kg/m^3)	930.7
Moisture content of oil (%)	1.23
Refractive index (at 40 ^0C)	1.43

V. CONCLUSION

An attempt was made to extract oil from Moringa Stenopetala seeds using a flush abstraction technique. Stochastic techniques, RSM and ANN were employed to model the oil extraction process. Optimisation of oil harvest was carried out by varying the extraction progression parameters including temperature, time, and particle size. Desirable properties were observed in the oil obtained from the seeds of Moringa Stenopetala. The research conducted using RSM analysis has identified the optimal process conditions for extracting the highest oil yield. The combination of the following key parameters was found to be the most effective. The study investigated the effect of particle size, temperature, and extraction time on the outcome of the experiment. The particle size used was 0.85 mm, while the temperature was set at 85 °C. The extraction process was carried out for a duration of 4.75 hours. Given the specified condition, the model made a prediction regarding the oil yield 39.5 %. The investigation and characteriszation of the physicochemical stuffs of the mined Moringa Stenopetala seed oil were conducted below optimised conditions. The results recommend that this oil might be a auspicious source of eatable oil for human eating.

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