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Research Paper

CHEMICAL TECHNOLOGY

Ultrasound-Assisted Optimization of Pectin Extraction from Orange Peel Using Response Surface Methodology (RSM) and Artificial Neural Network (ANN)

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ABSTRACT

The objective of study was extraction of pectin from orange peel using ultrasound assisted extraction and response surface method and artificial neural network technique. The accuracy of the two models was studied to compare the performances of the two models to make decision for achievement of optimum process parameters during extraction of the pectin. The following findings are absorbed from the effects of extraction parameters. The pH solution was highly significant compared to ultrasound power. As well as interaction between ultrasound and pH solution were found to be strongly influenced the extraction yield of pectin. The optimal parameters for extraction were irradiation time of 22.5 min, pH of 1.5, and ultrasound power of 155W and liquid-solid ratio 22.5:1 mL/ g. Under these conditions, yield of pectin was 26.87% experimentally, while 26.74 and 26.93% of yield were predicted by response surface methodology and artificial neural network model respectively. The extracted pectin of orange peel was categorized as high methoxyl pectin, since it has 63.13% degree of esterification, which is above 50% affirmed by Fourier transform infrared spectroscopy detection. Both response surface methodology and artificial neural network model prediction was in good agreement with experimental data; however, the prediction of artificial neural network prediction was better than artificial neural network. Therefore, artificial neural network model is much more accurate in estimating the values of pectin yield and mean square error when compared with the response surface methodology.

Keywords: Pectin, Orange peels, Optimization, RSM and ANN, Ultrasound assisted Extraction

Industrial wastes and accumulation generated per year are direct consequence associated with universe population growth that brings the environmental pollution issues. Food processing industry wastes and agricultural wastes rich in reusable materials are used for the bioconversion to value added products like

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additive product, biofuel and active biochemical materials (Salleh, Mahmoud, Karim, & Idris, 2011). One of, the largest product in worldwide per year are *citrus* fruits. Almost about fifty percent quantities of fruits are disposed as a waste by *citrus*-processing industries (Mahato *et al.* 2020; Sharma *et al.* 2017). Air quality, soil purity and sources of water around *citrus* processing industry, are directly consequences of problems, generated from these uncontrolled waste of this industry to the environmental (Zema *et al.* 2018). However, these products (*Citrus peels*) are used in several industries as polymethoxylated flavonoids that are applied as phytochemical, pharmaceuticals, food products (Kim *et al.* 2004) time, and HCl concentration of the washing solution were chosen as independent variables of the central composite design. The results showed a good fit with the second-order polynomial equation, which was statistically acceptable at P<0.05 level. Pectin loss was directly correlated with the increases in temperature, time, and HCl concentration during washing procedure.

Consequently, the higher the temperature and longer the time, the yield of narirutin extracted was greater, although higher HCl concentration had a negative effect on narirutin extraction yield. The present study indicated that the combination of washing temperature (62 °C. Conversion of these wastes to valuable product is considered as an alternate and common practices for recycling of byproduct and environmental management systems (Ng *et al.* 2020). One of the most source of raw materials largely produced in the worldwide are orange fruits used for extraction of complex compound known as pectin. Pectin is a complex polysaccharide substance contains one third of the mobileular wall of the plants. The larger amount of pectins are located within the middle part of lamella of cell wall and small amount of pectins are between the cell wall of plant (Abang *et al.* 2017). Pectin is used; as gelling, stabilizing and thickening agent jams and jellies confectionery in food as well as in pharmaceutical industry. In industrial level, pectin is divided as: Pectins with a degree of methylation (DM) above 50% (high methoxyl: HM) and pectins with a degree of methylation (DM) below 50% (low methoxyl: LM) (Hosseini, Khodaiyan, & Yarmand, 2016a). High methoxyl pectin makes gel between pH of 2–3.5 in the presence of concentrated co-solutes between 55–75%; while low methoxyl pectin forms gel in the absence of co-solutes, with the mixture of bivalent ions between pH of 2–6 (Chan & Choo, 2013). Therefore both types of pectins have dissimilar physical and chemical properties lead to dissimilar applications (Hosseini, Khodaiyan, & Yarmand, 2016b). In addition, properties of pectin primarily based on the plant source, the extraction technique chosen for separation as well as purity of final product. To increase extraction quality as well as the final yield of pectin, the use of an appropriate method is critical point (Berkani *et al.* 2020). Extraction of pectins from different plant sources haven been reported in several literatures. Anciently, extraction of pectins from *citrus* peels have done using hot acidified water that results destroying and make dissimilar its structure and instinctive character and usage of chemicals results wastewater which brings the higher environmental pollution (Hosseini *et al.* 2019a; Shivamathi *et al.* 2019). The use of several advanced techniques (including, enzymes, microwave as well as ultrasound assisted extraction (UAE)) can be used to maximize the final yield and its purity in addition minimizing; time of extraction, energy usage ,use of poisonous solvents and concentrated acid for product recovery (Marić *et al.* 2018). Due to the influence of ultrasound waves to improve the destroying of plant cell wall, increase the rate of mass transporting which bring up the better performance and quality of the product with a shorter time as well as lower consumption of solvents and energy, increased safety of the operators and in environmental problems, ultrasound assisted extraction is considered as alternative method (Hosseini *et al.* 2019; Marić *et al.* 2018). In overall, types of extraction variables involved and extraction mechanism will influence the efficiency of the yield.

For successful extraction and optimization, artificial neural network (ANN) and response surface methods (RSM) have been widely used in optimizing various process variables (Tesli *et al.* 2019; Ye *et al.* 2014). RSM is widely applied to optimize multivariate system to determine individual as well as combination influences of process parameters. However, RSM based models are only for a restricted range of input parameters and thus, impose a restriction on the use of RSM based models for non- linear behavior (Muthusamy, Manickam, Murugesan, Muthukumaran, & Pugazhendhi, 2019) "ISSN": "18790003", "PMID": "30414904", "abstract": In this work, Response Surface Methodology (RSM. Artificial neural network (ANN) has wide applications over RSM for non- linear multivariate modeling (Khayet, Cojocaru, & Essalhi, 2011) technology that includes different number of layers for selected number of parameters (Ghoreishi, Hedayati, & Mousavi, 2016). MATLAB® 2014a was used to build the ANN model with feed forward Multilayer back propagation (FMBP) to predict the response. Several investigations have been worked to extract pectin from orange peel using traditional as well as current methods. However, extraction of pectin from these peels was not investigated using combinations of current extraction method (UAE) and optimization (RSM and ANN*) methods. Therefore, the goal of this paper was ultrasound assisted extraction and optimization (response surface and artificial neural network) of pectin from orange peel.

MATERIALS AND METHODS

Materials

The orange peels were collected from juice producer located in Jimma. It was manually cleaned to remove impurity and dried for three days followed by an electric oven dry at 50 ºC until similar weight of the peel achieved. The dried peels were washed, mixed in a mixer grinder and sieved to avoid non-finely particles. The result powder was stored in a dark and dry out place for subsequent requirement.

Chemicals and solvents: Totally analytical grade reagent chemicals and solvents [Citric acid, HCl, HS_2O_4, trifluoro acetic acid, NaOH, ethanol, 2, 2-Diphenyl-1-Picrylhydrazyl] were purchased from chemical purchasers.

Experimental Design; Response surface method (RSM) modeling

Experiment design was developed using Stat Ease Design Expert software version 11.1.0. Based on the design of experiment; central composite deign, the second order polynomial regression model was developed to predict the performance of variables. The extraction parameters selected according to previous literatures as shown in appendix; A table 1 with coded and actual level.

The second-order models generated by RSM are often used to determine the critical points and can be written in a general form as (Kleijnen, 2008):

$$Y = \beta_0 + \sum_{i=1}^{k} \beta_i X_i + \sum_{i=1}^{k} \beta_{ii} X_i X_i + \sum_{i=1}^{k-1} \sum_{j=1+1}^{k} \beta_{ij} X_i X_j + \varepsilon \quad \ldots(1)$$

Where, Y, x_i and x_j, β_0, β_i, β_i, β_{ii}, k and are anticipated response, input factors, constant term, linear coefficient, quadratic coefficient, interaction term, number of factors and random error respectively.

Using Eq.(1), if n is the number of repetitions at the cube's center and R is the total number of run required for four independent variables (irradiation time, pH, Ultrasound power and liquid-solid ratio) is given by Eq.(2):

$$R = 2^k + (k*2) + n \quad \ldots(2)$$

Artificial neural network (ANN) modeling

MATLAB® 2014a was used for the formulation of Artificial neural network model using feed forward multilayer network contains three primary layers knwon as input (used hyperbolic tangent sigmoid transfer function), hidden and output layers (used pure-linear transfer function) to anticipate the yield (Nazerian, Kamyabb, Shamsianb, Dahmardehb, & Kooshaa, 2018) as indicated in Eq.(4). The developed artificial neural network model constitutes four inputs (irradiation time, pH solution, ultrasound power and liquid-solid ratio) and one output (pectin). The Marquardt–Levenberg back-propagation (MLBP) algorithm was selected for training. The input and output data detected from the actual values are categorized into different parts; (60% - eighteen samples) for training (20% - six samples) for testing and (20% - six samples) for validation. To find out best training efficiency and reduce the effect of larger values in input and output data, input and output were normalized between -1 and 1 (Muthusamy *et al.* 2019) "ISSN": "18790003", "PMID": "30414904", "abstract": In this work, Response Surface Methodology (RSM. The normalized data was forwarded to the artificial neural network model in feed forward multilayer back propagation. The mean square error values between the output neurons and the observational outputs were determined and backward propagated via the network. Then, the individual weights of the neuron, corrected by the algorithm. For cross-validation of parameters, by MATLAB, ANN Tool was developed. After the ANN tool memorizes the data from the training, the cross-validation was applied to prevent over fit of the training. By repetition in testing a number of NN, the best number of neurons in the hidden layer was determined when the mean square error (MSE) value of the output reached its minimum value. For determination of the number of neurons required in the hidden layer, addition of the weighted inputs and the related bias are important data towards for nonlinear situation (Cheok *et al.* 2012) solid to solvent ratio, and methanol concentration for extracting total phenolic content (TPC; Madadlou *et al.* 2009) one hidden layer and an output layer with one neuron optimized using response surface methodology (RSM

$$F(x) = tansig(x) = \frac{1-e^x}{1+e^x} \quad \ldots(4)$$

Comparison of ANN & RSM performance

The coefficient of determination; R^2, Root Mean Squared Error; RMSE, mean average error; MAE, standard error of prediction; SEP, and absolute average deviation; AAD were determined to check the accuracy and predictive ability of ANN and RSM using Eq. (4):

$$R^2 = 1 - \sum_{i=1}^{r} \left[\frac{\left(y_p - y_e\right)^2}{\left(y_p - m\right)^2} \right] \quad \ldots(4)$$

$$MSE = 1 - \frac{1}{r}\sum_{i=1}^{r}\left(y_p - y_e\right)^2 \quad \ldots(5)$$

$$RMSE = MS\,E^{1/2} \quad \ldots(6)$$

$$\text{SRP} = \frac{RMSE}{m} \quad \ldots(7)$$

$$\text{AAD} = \frac{100}{r}\sum_{i=1}^{r}\left(\frac{y_e - y_p}{y_{\exp}}\right) \quad \ldots(8)$$

$$\text{MAE} = \sum_{i=1}^{r}\left[\frac{y_e - y_p}{y_e}\right] \quad \ldots(9)$$

Where; r = number of run, y_p = predicted values from model, y_e = experimental values and m = average experimental values

Extraction of Pectin

By using previous study as reference with modification and it should also be declared that the degrees of parameters were selected depend on previous study (Hosseini *et al.* 2019; Lin *et al.* 2018) there is a lack of studies on the extraction of pectin by ultrasound assisted extraction (UAE. In all runs, fifteen gram (15g) of the peel powder was mixed with pH of (13) citric acid solution in 250ml flask. It was then sonicated for (1530 min), in the range of (60120W), ultrasound power, thereafter the mixture was maintained at temperature of 25^{0}C for a certain time and percolated. The percolate carrying pectin was chilled down, for 25 min and centrifuged at 6500 rpm. Ethanol of 96% was utilized, to precipitate the supernatant and impurities, and allowed for one hour for pectin flotation. The floating result was then classified by filtration process and the end result was dried in drier at 50°C to remove moisture. The resulting dried pectin was milled to powdered pectin and stored for analysis and its yield was determined using to Eq. (2) and indicated in table 2.

$$\text{Yield (\%)} = \frac{\text{Amount of dried pectin extracted in gram (g)}}{\text{Amount of sample taken upfor extraction in gram (g)}} * \times 100 \quad \ldots(10)$$

FT-IR spectroscopy

The produced pectin contents were analyzed by using prinks Elmer spectrum 65 FT-IR technique with the help of IR correlation. The wavenumber region for the analysis was 4000-400 cm^{-1} (in the mid-infrared range) and IR spectrum was reported by % transmittance.

Table 1: central composite design parameters level for pectin extraction

Parameters	Unit	Minimum	maximum	Levels		
A: Irradiation time	min	15	30	10(-1)	25(0)	40(+1)
B: pH solution	–	2	3	2(-1)	2.5(0)	3(+1)
C: Ultrasound power	w	60	140	60(-1)	100(0)	140(+1)
D: Liquid-solid ratio	mL/g	15:1	25:1	15:1(-1)	20:1(0)	25:1(+1)

Table 2: Independent variables with experimental and response with RSM and ANN

Run Order	Factors				Actual %	RSM Predicted %	ANN Predicted %
	Irradiation time min	pH solution	Ultrasound power (W)	L-S-R (ml/g)			
1	30	2	120	30	20.01	20.10	20.4683
2	15	3	120	15	9.90	9.91	9.899
3	22.5	2.5	85	22.5	23.23	23.17	23.21
4	15	3	50	30	11.30	11.33	11.2922
5	30	3	120	30	10.30	10.30	10.301
6	30	2	50	15	16.30	16.53	16.54
7	22.5	2.5	85	7.5	16.70	16.44	16.8996
8	37.5	2.5	85	22.5	7.30	7.14	7.361
9	30	2	120	15	22.57	22.61	22.5638
10	7.5	2.5	85	22.5	8.50	8.25	8.4994
11	22.5	2.5	15	22.5	15.80	15.52	15.783
12	22.5	2.5	85	37.5	16.70	16.55	17.098
13	22.5	2.5	85	22.5	23.40	23.17	23.21
14	30	2	50	30	15.01	14.94	13.5319
15	22.5	1.5	155	22.5	26.87	26.74	26.93
16	22.5	3.5	85	22.5	5.75	5.47	6.1308
17	15	2	50	30	15.00	15.19	14.9644
18	30	3	50	30	10.00	10.29	10.2657
19	15	3	50	15	8.31	8.70	9.5966
20	30	3	50	15	8.10	8.10	8.2907
21	22.5	2.5	85	22.5	23.10	23.17	23.21
22	15	2	120	30	20.54	20.61	21.0478
23	15	2	120	15	22.50	22.69	22.75164
24	22.5	2.5	85	22.5	23.00	23.17	23.21
25	15	2	50	15	16.40	16.34	16.4342
26	30	3	120	15	8.88	9.04	8.938
27	22.5	2.5	85	22.5	22.99	23.17	23.21
28	22.5	2.5	85	22.5	23.40	23.17	23.21
29	22.5	2.5	85	22.5	23.23	23.17	23.21
30	15	3	120	30	11.50	11.61	11.4755

Product (Pectin) characterization

The pectin extracted at the optimum processing conditions (the highest yield) was analyzed by determining the following properties.

Esterification Capacity/degree of esterification (EC): It was calculated using the titrimetric method using potassium hydroxide (KOH), instead of sodium hydroxide. Twenty-five (25g) of dried product was moistened with standard ethanol and dissolved in 25 ml of deionized water at forty degree Celsius (40 ^{0}C). Following full dissolution of product, five pearls of indicators were added to the mixture. The mixture was thereafter volumetrically analyzed with 0.4 M KOH, and the amount of the KOH solution used for color change was recorded as volume (V_1). Subsequently, 15 ml of 0.4 M KOH was added, and the solution was shaken powerfully and allowed to cool down for 10 min. In addition, 15 ml of 0.6 M hydrochloric acid was added and the solution was shaken until the disappearance of pink color. The mixture was volumetrically analyzed with 0.4 M KOH for the end step and the consumed amount was collected as volume (V_2) and the esterification capacity was determined using Eq. (11):

$$\text{EC}(\%) = \frac{V_2}{V_1 + V_2} * 100 \qquad \ldots(11)$$

EC = esterification capacity of dried product, V_1 = initial titer (ml), and V_2 = final titer (ml)

Equivalent weight (EW): This was calculated as method reported by (Mohamed, 2016); 5 g of dried product was put in a 250 ml conical flask, and 15ml ethanol was added. One gram of NaCl and 100 ml of deionized water were added. Finally, five drops of phenol red indicator was added and volumetrically analyzed with 0.1 M KOH. The end of volumetric analysis was represented by pink color and the equivalent weight was calculated according to Eq. (12):

$$\text{EW}(\%) = \frac{m_s * 1000}{V_a * K_n} \qquad \ldots(12)$$

EW= Molecular mass of dried product, VA = volume of alkali (ml), and K_{en}= normality of potassium.

Methoxyl content (MC): MC was carried out using the Ranganna's method as reported by (Fakayode & Abobi, 2018). When the neutral solution was accumulated from determination of equivalent weight, 20 ml of KOH was added. The mixed solution was stirred thoroughly and kept at 25^{0}C for 25 min. Then after, 25 min, 20 ml of 0.3 M HCl introduced and volumetric analysis started with 0.1M KOH. The content of methoxyl was calculated using Eq. (13):

$$\text{MC}(\%) = \frac{V_a * N_a * 3.1}{m_s} \qquad \ldots(13)$$

MC = methoxyl content of dried product

Total anhydrouronic acid content (TAAC): This was carried out using the method adopted by Mohamed, (2016) and determined using Eq. (14):

$$\text{TAAC}\ (\%) = 1.76 * \frac{(a+b)}{m_s} \qquad \ldots(14)$$

TAAC = total anhydrouronic acid content of dried product a = volume of KOH from equivalent weight determination (ml), and b = volume of KOH from methoxyl content finding (ml) and m_s = mass of sample (g)

Acetyl value (AV);- This was carried out using the Ranganna's method as reported by (Kliemann *et al.* 2009); 5 g of dried product was dissolved in 0.2 M KOH solution by stirring and allowed to stand overnight. The contents were diluted to 40 ml with deionized water and an aliquot (15 ml) was located into the distillation equipment. Magnesium sulfate-sulfuric acid mixture (15 ml) was also shifted to distillation equipment and distilled. About 100 ml of distillate was collected and the distillate was titrated with 0.4 M KOH using phenol red indicator. A blank distillation using 15 ml of the Magnesium sulfate-sulfuric acid solution was carried out, and the distillate was volumetrically analyzed. The acetyl content was calculated using Eq. (15):

$$\text{ACV}(\%) = \frac{V_a * N_a * 4.3}{m_s} \quad \ldots(15)$$

ACV = acetyl value of dried product

RESULTS AND DISCUSSION

Validation of RSM model optimization for experimental data analysis

A very good correspondence between the observational and anticipated values for pectin yield was obtained from the check bit plot between the anticipated and the observational values as shown in Fig. 2. The anticipated values and observed values are in reasonable agreement, since there is closeness between the both results for pectin yield. Referencing table 2, the expected optimum pectin yield was 26.74% at time of 22.5 min, pH of 1.5, ultrasound power of 155W, and liquid-solid ratio of 22.5:1 mL/g using Eq. (10). Under these conditions, the actual value of pectin was 26.87%, which in corresponding with those expected by computation.

The UAE yield of pectin was less than the result reported by, Hosseini *et al.* (2019) from microwave-assisted extraction (28.07 ± 0.67 %) and higher than, Hosseini *et al.* (2016) aqueous extraction (17.95 ± 0.3%) in their optimum extraction conditions. The variation could be due to; plant source, the extraction technique taken for separation (Hosseini *et al.* 2016b). However, the result indicates that the UAE method is an efficient technique since; this it has minimum consumption of time and energy and in addition, that the extracted yield of pectin in this research was better than result achieved by Wikiera *et al.* (2016) 19.8% of pectin yield from apple pomace by Endo-xylenes and endo-cellulose-assisted method. Shivamathi *et al.* (2019) has reported the achievement of 8.93% yield of pectin from custard apple peel at optimized conditions. This implies that the model chosen for anticipation of the pectin yield from orange peel was adequately.

The regression coefficient (interms of coded), variance analysis of the expected model and all colleration coefficients(R^2, R^2 adj and R^2 pre) have been used to test the goodness of the model (Zhang, Chen, Mao, Guo, & Dai, 2014) "ISSN": "18790003", "abstract": The central composite design (CCD listed in table 3. The analysis results proved that the relationship between factors and the response of the expected

model was well-correlated. Residual is the difference between the actual and the fitted value of a model and it is used to predict the adequacy of the model. Small residual mean's; model anticipated is accurate (Samavati, 2013) based on a five level, four variable central composite rotatable design (CCRD. The statistical effluences of all the terms of the model were tested by the F and P-value. The corresponding variables would be more significant if the F-value became higher and the P-value became smaller (Zhang *et al.* 2014) "ISSN": "18790003", "abstract": The central composite design (CCD. In this study, results showed that, high F-value and p value of developed model were below 0.05, which in turn show the fitness of model was strongly significant (Prakash *et al.* 2013). The results also proved that, the proposed regression model for pectin yield was satisfactory high with all squared R values table 3, which exhibited a closeness between the actual and the anticipated values by the model.

Table 3: ANOVA for Quadratic model

Source	Sum of Squares	DF	Mean Square	F-value	p-value
Model	1160.73	14	82.91	1305.28	0.0001***
A-irradiation time	1.86	1	1.86	29.27	0.0001***
B-pH solution	362.96	1	362.96	5714.31	0.0001***
C-Ultrasound power	48.42	1	48.42	762.26	0.0001***
D-L-S-R	0.0204	1	0.0204	0.3214	0.5791*
AB	0.6320	1	0.6320	9.95	0.0065**
AC	0.0729	1	0.0729	1.15	0.3010*
AD	0.1936	1	0.1936	3.05	0.1013*
BC	34.80	1	34.80	547.81	0.0001***
BD	14.29	1	14.29	224.95	0.0001***
CD	0.8556	1	0.8556	13.47	0.0023**
A^2	414.24	1	414.24	6521.56	0.0001***
B^2	91.14	1	91.14	1434.84	0.0001***
C^2	22.57	1	22.57	355.40	0.0001***
D^2	77.15	1	77.15	1214.57	0.0001***
Residual	0.9528	15	0.0635		
Lack of Fit	0.7772	9	0.0864	2.95	0.1004*
Pure Error	0.1755	6	0.0293		
Total	1161.68	29			
R^2			0.9678		
Adj.R^2			0.9475		
Pred. R^2			0.9575		
Ade Pr.			26.3910		
Std. Dev.			1.14		
Mean			15.78		
C.V. %			7.23		

Highly significant; ***, significant; **, not significant; *

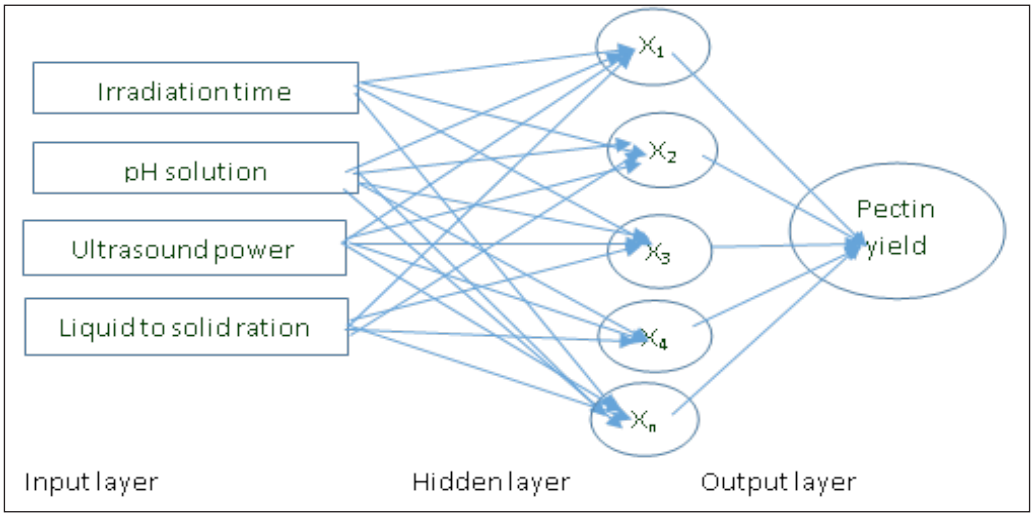

Fig. 1: Artificial neural network for input, hidden and output layers (4–X_n–1)

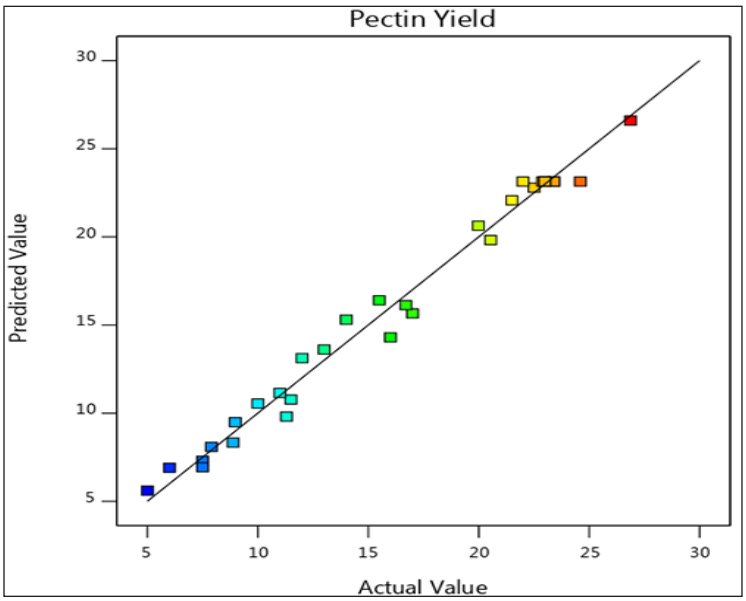

Fig. 2: Experimental value versus RSM expected of pectin yield (%)

The Pred. R^2 of 0.9575 is in reasonable estimate with the Adj. R^2 of 0.9475; i.e. the distinction is much less than 0.2. The adequate precision ratio of 58.439 shows an adequate signal and this model can be used to navigate the design space since, adequate precision is used to find out the signal to noise ratio and a ratio greater than 4 is desirable. Meanwhile, the very small value of coefficient of variation (CV:7.23%) clearly shown a very strong degree of precision and a great deal of reliability of the experimental values

(Prakash *et al.* (2014). The F-value of 2.95 the lack of fit for this estimation shows that, the model is suitable for anticipation of optimum conditions to extract pectin from orange peel using UAE. The proposed quadratic polynomial model is therefore, perfectly suitable for anticipation of the relationship between independent and dependent variables. The dependent and independent variables are related by the following second-order polynomial equation interms of coded terms by applying multiple regression analysis on the experimental data.

Final Equation in Terms of Coded Factors

$$\text{Pectin Yield} = +23.17 - 0.28A - 4.36B + 1.59C + 0.03D - 0.2AB - 0.07AC - 0.11AD - 1.28BC + 0.95BD - 0.23CD - 3.87A^2 - 2.25B^2 - 1.12C^2 - 1.67D^2 \quad \ldots(16)$$

The importance of the independent variables and their effects could be indicated by the magnitude and sign of the coefficients (Zhao-Hui *et al.* 2011). It could be seen from table 3 and Eq. (16), all the liner, the quadratic and the interaction coefficients (BC, BD, CD) were statistically significant.

Effect of extraction variables on the pectin yield

The result in table 3 and Eq. (16) separately showed that all of the applied factors were highly effective on extraction yield of pectin except liquid-solid ratio not significant. Citric acid pH solution should be considered more than the other factors, since it was the most influential on extraction process. Similarly the interaction between pH, solution versus ultrasound power and pH solution versus liquid-solid ratio had a high influence on the yield of extraction. Apart from the liquid-solid ratio and pH solution, the interaction between pH and ultrasound power had highly influenced the yield of pectin. The 3D plots were demonstrated below for more exploration in the relationship between response and parameters. At the least pH solution and highest ultrasound power, the maximum extraction yield was attained. This means, high acidic media, brought the pectin leakage from the plant substance and in consequence, increased the extraction efficiency (Hosseini *et al.* 2019b and Dranca, 2019). Another efficient variable that had a direct influence on the extraction was ultrasound power. Fig. 3a reveals that ultrasound power was better efficient in the study, enhancing the ultrasound power; the extraction efficiency was also enhanced. This result may relate to the cavitation consequences of ultrasound waves and this cavitation bring up the solvent insight into intercellular substance of plant and thereby upgrades the pectin escapees leads to increase the extraction efficiency (Wikiera *et al.* 2016).

Irradiation time is one of the important process parameters that affect the yield of pectin significantly compared to L-S-R in this study. Due to creation of the cavitation bubble by ultrasound waves that supports the disruption of plant cell wall to improve the extraction efficiency of pectin and produce swelling and hydrate the plant material, in the initial stage, the extraction efficiency was increased up to 22.5 min and the reduction was observed above this value (Shivamathi *et al.* 2019).

Yield of pectin did not highly influenced with liquid-solid ratio compared to other parameters; an observation that was confirmed by the results of the analysis of variance ($p > 0.05$) and Eq. (16). It can be assumed that varying the range of study above a SLR of 1:22.5 g/mL might be lead to a different conclusion regarding the involvement of this working parameter in the cavitation effect occurring in an extraction assisted by ultrasound method and consequently its impact on the efficiency of extraction (Dranca, 2019).

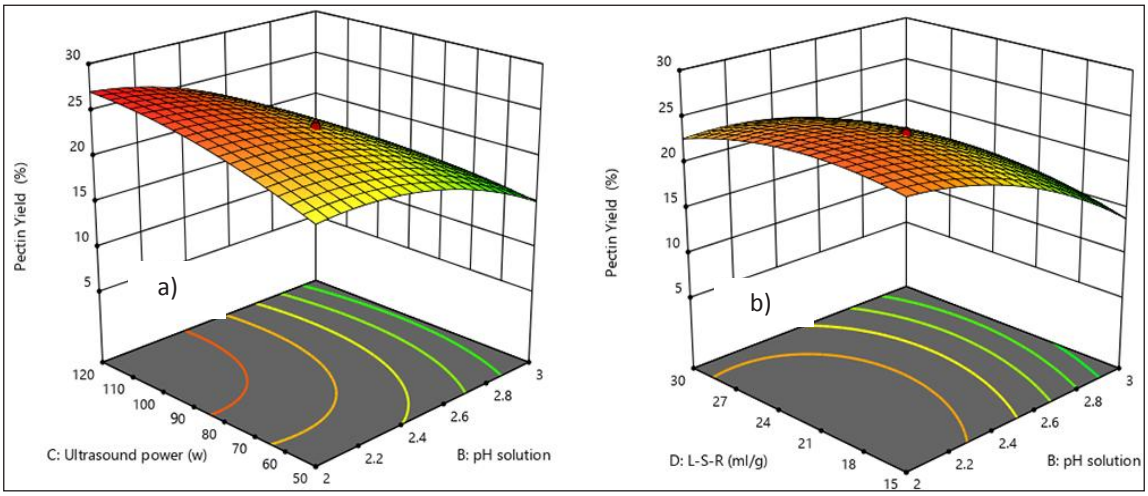

Fig. 3: Ultrasound versus pH (a) and Liquid-solid ratio versus pH on the yield of pectin (b)

ANN-based modeling

The ANN anticipation has been carried out successfully using information shown in indicated in table 1. The ANN-based model was done by; choice of the appropriate training algorithm, determination of optimum value of neuron and validation of the model. Eighteen (80% –18) samples of the data were used for training, six (20%–6) samples for testing and six (20%–6) samples for validation. Using the available actual value, Levenberg–Marquardt (LM) ANN fitting tool and TANSIG Transfer Function 4–X_n–1 (number of input layer, neurons in hidden layer and output layer) model were implemented. Prior training, the network inputs and target were normalized by assigning the maximum (+1) and minimum (–1) levels. Statistical parameters like R; regression coefficient, RMSE; root-mean square error, MAE; mean average error, SEP; standard error of prediction and AAD; absolute average deviation were assumed to determining the higher predictive power of the model techniques. The statistical values of ANN and RSM models are decided using Eq. (4–9) and shown in table 4.

Table 4. Relative statistical indicators values of RSM and ANN model

Variables	RSM	ANN
R^2	0.9678	0.9990
RMSE	0.627368	0.568154
SEP	0.007201	0.006576
MAE	0.521	0.352
AAD	0.547091	0.37780

The degree of association or relationship among the parameters in the question was specified by correlation coefficient (R). A unit (1) value of coefficient of correlation implies perfect relationship between variables while zero (0) value is believed to be the absence of linear relationship the parameters. The best solution was chosen based on highest coefficient of correlation and least MSE for training, testing and validation. The correlation coefficients (R) between the actual and the expected values are 0.99943 for training, 0.9863

for testing, 0.99615 for validation and overall correlation was 0.99769. Therefore, the ANN anticipation for training, validation, and testing is highly substantial and meritorious in terms of correlation. As indicated in indicated in Fig. 4 and, the performance value for the final iteration gave a best result.

Comparison of RSM and ANN Performance

To identify the best model that accurately predict the effect of extraction parameters on the yield, the prediction capabilities of the RSM and ANN models the computed values of all statistical indicators were compared. The result showed that both models indicates high of accurate of the result, since the higher R^2 values were predicted in both cases. However, ANN gave a lower RMSE value when compared to the RSM model. Therefore, ANN was a better modeling tool due to its low RMSE and high extract yield. Owing to higher value of R^2 and lower values of other statistical values of ANN compared to RSM, the accuracy of ANN model is better than that of the RSM model.

Product Characterization

The analyzed characteristics of the extracted pectins were indicated with their values and summarized in table 5.

Table 5: Properties of extracted pectin with their values.

Parameters	Current Value (%)	Previous value (%) and References	
		Rahmani *et al.* (2020)	Mohamed, (2016)
Methoxyl content	6.43	6.23	8.875
Anhydrouronic acid	68.25	70.9	60.95
Acetyle content	0.371	0.4	0.455
EC	63.13	60.4	55.01
MW	604.74	599.74	–

To represent the extent to which carboxyl groups in pectin molecules exist as the methyl ester, esterification capacity (EC) is an essential molecular index for pectin classification. Since result indicates, higher degree of esterification above50 percentage, it can be considered as high methoxyl (HM) pectin. Pectin's has high tendency to form gel rapidly at higher temperature and have a great effective action on the lipid profile, when degree of esterification is above 50 percent (Brouns *et al.* 2012) molecular weight (MW; Dominiak *et al.* 2014). However, esterification capacity shows only the ratio between methanol-esterified carboxyl groups and free carboxyl groups, whereas the methoxyl rate represents to the amount of methoxyl groups in a sample (Fakayode & Abobi, 2018). So, the EC could not be judged separately, as it does not show the actual amount of methyl esterification, especially when the galacturonic acid amount is low. High methoxyl pectins (above 50% EC) require a relatively a low pH for gel formation and large concentration of soluble solids, while pectins having methoxyl below 50% EC, establish in flexible gels the using the movement of multivalent cations, which cross-hyperlink the galacturonic acid chains (Garna, Mabon, Wathelet, & Paquot, 2004). In present study, the esterification capacity (EC) of the hydrated pectin was 63.13% similar to previous studies as shown in table 4.

Another important characteristic in classifying the functional behavior of pectin is equivalent weight (EW) since, gelling tendency of individual pectin's are linked very closely with EW. The higher equivalent

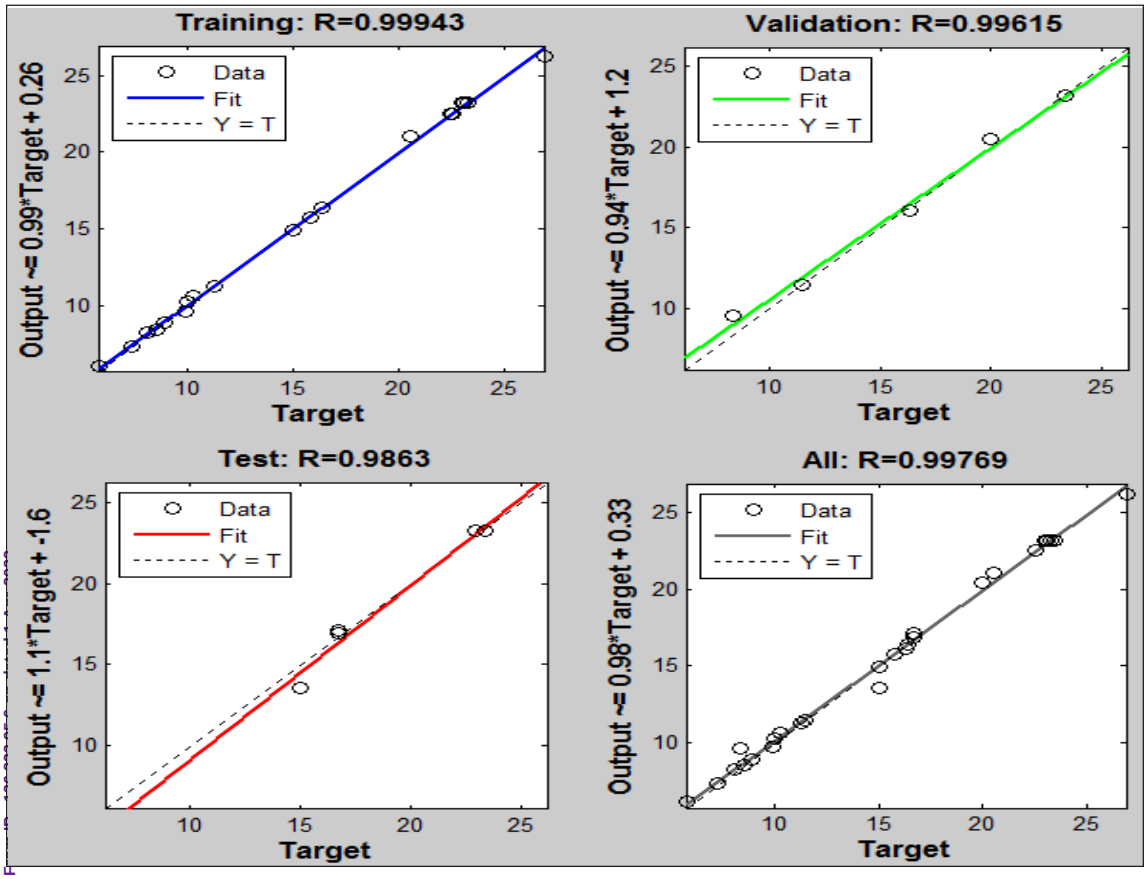

Fig. 4: Correlation coefficients for mean pectin yield (ANN)

weight, has greater gel formation, while the lower equivalent weight, indicates larger partial degradation of the pectin which is non-profitable (Hardy, 1924) strawberries, rhubarb stem and apples, Schryver and Haynies [1916] employed a hot dilute solution of ammonium oxalate to extract pectinogen from the washed and dried material. Subsequently, Farnell [1923], working in conjunction with Schryver, showed that oxalic acid could be substituted for the salt, and indeed, is preferable in so far that it remains in solution when the extracted pectinogen is precipitated by alcohol, whereas ammonium oxalate is strongly adsorbed by the alcohol-gel. Farnell also demonstrated that solutions of ammonium sulphate and of carbonic acid are capable of extracting appreciable amounts of pectinogen from dried turnip, but that water alone is without effect. He suggested that pectinogen is loosely combined with calcium in plant tissues, and is liberated therefrom by any reagent which precipitates the metal. Carre [1922] has, however, shown that dilute hydrochloric acid is an effective extractor of pectinogen, a result which is not concordant with this generalisation. In examining the factors which influence the extraction of pectinogen from the fibre of sugar cane, Farnell (private communication and thus the raise or diminish of the equivalent weight could be subjected to the content of free acid (Mohamed, 2016). The average equivalent weight of orange peel pectin in this study found to be 604.74 kDa closest to data reported by Altaf *et al.* (2015) at different time, temperature and pH combinations. Extraction was done at temperatures 60°C, 70°C and 80°C for

time 30 mins, 45 mins and 60 mins, and pH 2, 2.5 and 3.0 respectively. Using hydrochloric acid, the yield of pectin was higher (ranging from 2.8%-16%, that the equivalent weigh of the pectin extracted form papaya fruits using HCl and Citric acids were 912.17 and 455.1 respectively and stated that, pectin produced at lower pH value, has higher equivalent weight, since lower pH can lead polymerization of pectin into an extended chain, and in turn decrease the amount of free acid..

The methoxyl content (MC) is an instrument tool used to control the setting time, the gel strength and to find the functional properties of pectin (Twinomuhwezi, Godswill, & Kahunde, 2020). Kanmani, (2014) established that, depending on the origin of raw material used, method of extraction, in addition to the method used for determination of methoxyl content, the MC of pectin usually varies from 0.2–12%. The result indicated that 6.23% of methoxyl content was achieved. Since the methoxyl content was below 12%, this pectin has lower ester characteristic, which implies that it is desirable in terms of quality, and in addition due to it has above 50% DE.

As indication of Food Chemical Codex (FCC), Food and Agriculture Organization (FAO), and European Union (EU), pectin must contains at least 65% of galacturonic acid (Willats, Knox, & Mikkelsen, 2006), since anhydrouronic acid amount is used to represent the gelling capabilities of given pectin. The higher value means, the produced pectin has a lower amount of protein. In present study, the result indicated that 68.25% of anhydrouronic acid was achieved. A minimum value of anhydrouronic acid (65%) for commercial pectins has been specified by FAO (Twinomuhwezi *et al.* 2020). This criterion has limited the potential sources of food and pharmaceutical pectins.

Acetyl value (AV); the gelling capacity of pectin diminished with the raise in the degree of acetylation (Fakayode & Abobi, 2018). The inhibition of gelormation will be created when acetyl formation is found in pectin. Other researcher shown that the gelling capacity of pectin diminished with raise in the degree of acetylation and samples holding 3.5%-4.0% acetyl brings weak gels while gelling capacity restored at levels around 2.4% acetyl (Mohamed, 2016). Based on acetyl value and compared to previous study, the result indicates that orange peel pectin has good gelling capacity (0.371%) indicated in table 5.

CONCLUSION

The ultrasound-assisted extraction of pectin was optimized by the combination of both response surface methodology (RSM) and artificial neural network multi-layer back propagation (ANNMBP). The objectives of study were extraction of pectin from orange peel using ultrasound assisted extraction and response surface method and artificial neural network technique. The accuracy of the two models were studied to compare the performances of the two models to making decision for achievement of optimum process parameters during extraction of the pectin.

The following finding are absorbed from the effects of extraction parameters. The ultrasound assisted extraction and pH of citric acid solution applied for the extraction of pectin were found to be strongly influenced the yield. However, pH solution was highly significant compared to ultrasound power. As well as interaction between ultrasound and pH solution were found to be strongly influenced the extraction yield of pectin. The optimal conditions for extraction were irradiation time of 22.5 min, pH of 1.5, and ultrasound power of 155W and liquid-solid ratio 22.5:1 mL/ g. Under these conditions, yield of pectin was 26.87% experimentally, while 26.74 and 26.93% of yield were predicted by RSM and ANN model respectively.

The extracted pectin of orange peel was categorized as high methoxyl pectin since it has 63.13% degree of esterification that is above 50% affirmed by FTIR detection.

The prediction of yield was investigated by using RSM and ANN model and found to be in good agreement with experimental data, however, the prediction of ANN model is found to be better than RSM. The results indicates that, ANN model is much more accurate in estimating the values of pectin yield and mean square error when compared with the RSM.

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Acronyms

A	:	Irradiation time
ANOVA	:	Analysis of Variance
B	:	pH: power of hydrogen
C	:	Ultrasound power
C.V	:	Coefficient of variation
D	:	Liquid to solid ratio
KOH	:	Potassium hydroxide
R^2	:	Coefficient of determination
RSM	:	Response surface method
Std. Dev.	:	Standard deviation
FTIR	:	Fourier Transform Infrared spectroscopy
ANN	:	Artificial neural network
W	:	Watt

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Research Paper

APPLIED CHEMISTRY

Stabilization of Natural Rubber against the Effect of Cyclic heating at Different Temperature using Cashew Nut Shell Liquid (Technical CNSL)

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ABSTRACT

Natural rubber being a polymer formed in plants has very limited usefulness if not processed further. The processed (vulcanized) rubber can be further stabilized against thermal oxidation and degradation when put to use to extend the life span. The effect of cyclic heating on natural rubber treated with cashew nut shell liquid (CNSL) was determined. The natural rubber samples were dissolved in a given di-ethyl ether and a measured quantity of paraffin was added and divided into two (2) parts. The first groups were samples without stabilizing additive while the other contains stabilizing additive blended in them. The samples were heated at 60^0C, 80^0C and 100^0C over varying periods of 3, 6, 9, 12 and 15 hours respectively and the compounded dried rubber was weighed into each of 12 cavities of a locally fabricate aluminium mould and the mould and its contents introduced into the oven. A solution of a measured amount of each sample in hexane was taken for viscometric measurement. Change in viscosity with length of heating shows that the various samples were degraded with time. The level of degradation of the rubber samples treated with cashew nut shell liquid (CNSL) as stabilizer showed better thermal stability compared with those without stabilizing additive.

Keywords: Natural Rubber, Cashew Nut Shell Liquid, Stabilize, Heating, viscosity

Natural rubber, a form of polymer, has been processed by vulcanization which has made it very important article of commerce and industry. Nevertheless, thermal effects on polymer degradation are a major drawback to polymeric materials. The exposure of polymers to a relatively high temperature during processing, and to moderate temperature during long term ageing, accounts for failure of most polymers. Absorption of thermal energy and atmospheric oxidation are a primary environmental factor responsible for instability of polymeric materials. However, thermal effects are generally evident in reactions that are temperature dependent which results in polymer degradation or deterioration (Lincoln, 1971).

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The resistance of polymer to thermal oxidative degradation can be increased by a variety of chemical modification. Plants sources that are processed into rubber products that are useful depends heavily on vulcanizing agents (e.g. Sulphur), accelerators (thiazoles and sulfonamides), stabilizing agents (e.g. butadiene, styrene, PVC, Aluminium hydroxide) and complex processing resins. Stabilization process against degradation in polymerization offers improved and long life span of polymers when they put long term use. Research works have shown that the level of polymer deterioration is determined by its physical structure and environmental condition of exposure. Therefore, the choice of stabilizers is directly connected to the vulnerability of the base polymer to degradation.

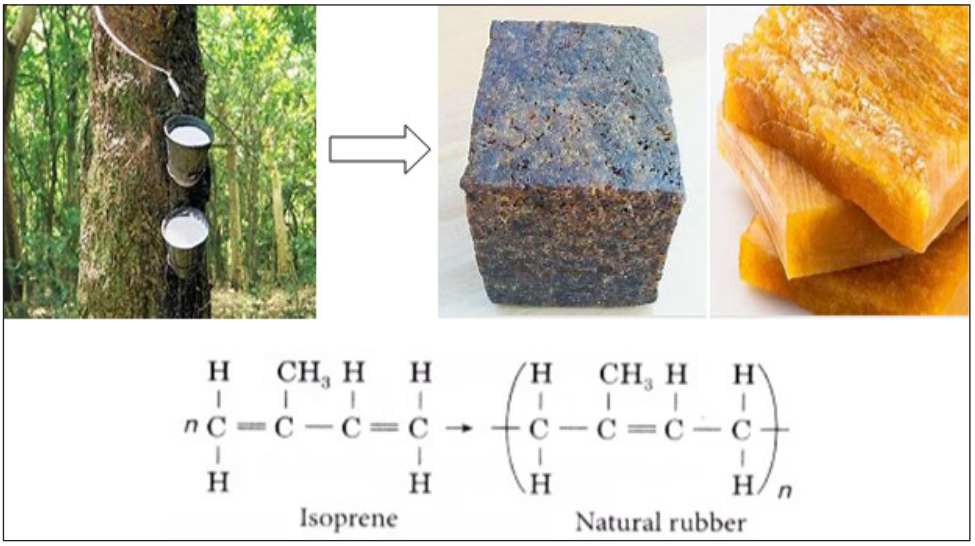

Fig. 1: Natural rubber and its chemical formula where n = 100,000 and above

CNSL is one of the good natural sources of unsaturated long chain phenol as it is renewable and cheap substance which is easily available as by-product of industries that produces cashew (Francisco, 2006). CNSL can be applied in rubber compounding as it has many miscellaneous applications. Its low cost, availability and reactive nature makes it an alternative in industrial production of some materials. It is a by-product from cashew nut processing industries, is dark brown viscous oil present inside a soft honey comb structure of the cashew nut shell as shown in Fig. 4. It has phenolic compounds which is mainly cardanol as can be seen in Table 1. Cardanol is a monohydroxyl phenol with a long carbon chain in the meta-position as shown in Fig. 1a - d. This oil extracted from the shells contains alkyl-substituted phenolic compounds. These molecules show antioxidants properties due their structures and have the potential as substitute for phenol in phenolic-base chemical products (Damodhar *et al.* 2014). The use of added stabilizing agents to protect polymers against thermal oxidation is very important for most polymeric materials. It has been reported that the ageing phenomenon coincided with oxygen absorption and was retarded by phenolic substances (Semon, 1997). Eventually, a general theory of anti-oxidant emerged from the work carried out at Natural Rubber Research Producers, Research Association in England (Bateman, (2001), where it was clearly shown that hydroperoxide and free radicals were key intermediates in the oxidation of hydrocarbon. In the past decades, phenolic resins have become of increasing significance in rubber compounding. The resin based on cashew CNSL which contains phenolic bodies such as anacardic

acid which, when treated or blended with hexamine, can be incorporated into nitrile rubber (butaniene-acrylonitrile). More so, resins based on the reaction products of cardanol, phenol and formaldehyde is used to improve rubber materials resistance to cracking and ozonation degradation (Matthew *et al.* 2005). Various study also have shown that biological activities of the various components of CNSL have attracted considerable attention in the areas of fungicidal activity (Kubo *et al.* 2006), anti-inflammatory activities (Schmourlo *et al.* 2005), anti-oxidant activity (Amorati *et al.* 2001) and xanthine oxidase inhibition (Masuoka and Kubo, 2004).

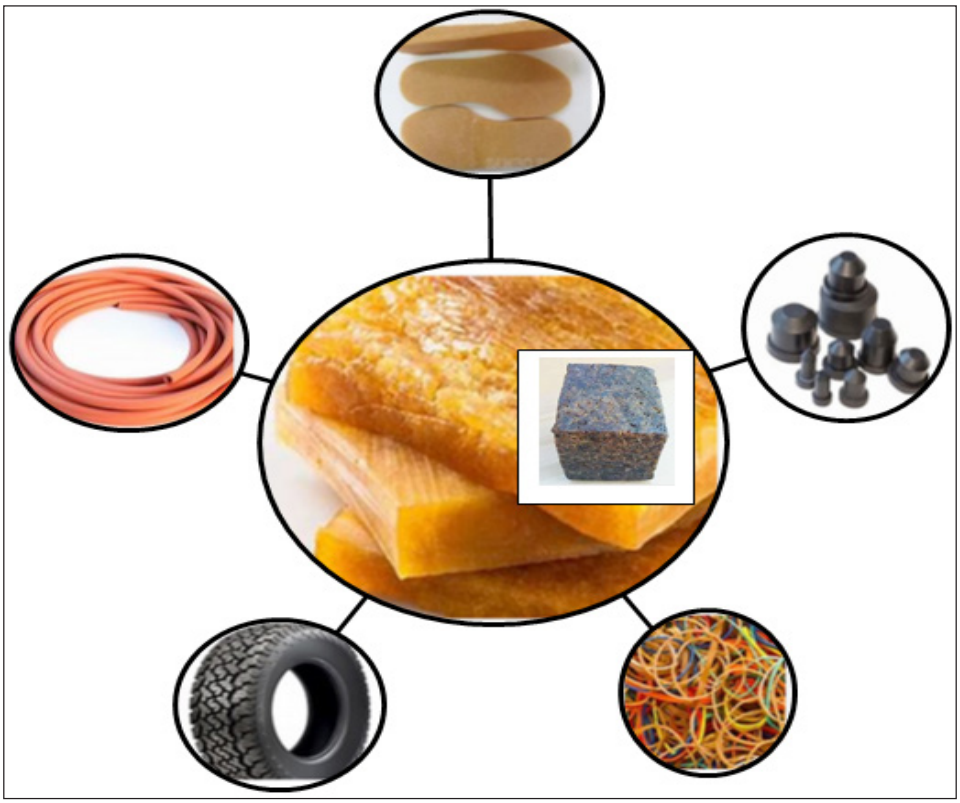

Fig. 2: Some products obtained from natural rubber that can be stabilized with CNSL against thermal degradation

Table 1: Components of solvent technical CNSL

Component	Technical extraction (%)
Anacardic acid	0 (transformed to cardanol)
Cardol	8 – 11
Cardanol	83 – 84
2-methyl cardanol	Not documented
2-methyl cardol	2
Polymeric matter	10

Nigeria, agriculture and diversification; a focus on cashew seed oil

Nigeria is a producer of rubber trees (*hevea brasiliensis*) from which the latex is extracted (Fig. 1) and is at the verge of economic diversification due to the recent economic meltdown as a result of over dependent on the oil sector. As a matter of urgency, the agricultural sector is been exploited to reduce the pressure on the oil sector. The current global challenge due to the prevailing COVID-19 pandemic has also greatly affected the economics of many Nations with a little chances of recovery for most Nations in some years to come. This is a wakeup call to diversification of economies of all Nations at the very moment with the agricultural sector been the frontier. Nigeria is among the four major cashew producing regions including India, Brazil, and Tanzania. According to Food and Agricultural Organization (FAO), the production of cashew nuts in Nigeria in the previous decade has increased from 176,000 MT in 2000 to more than 836,500 MT currently (FAO 2016). The cashew plant has suffered neglects for a long time but, is now the focus of some industries because CNSL is the major by-product utilized by some industries especially plastic industries in which some of their products are shown in Fig. 2. There are a large number of plants materials such as trees, shrubs and herbs which are present in Nigeria that can also be used as bio-fuel. As a result of depleting reserves of fossil fuels and increasing demand for diesel, alternate sources in their availability have been receiving researchers' attention globally, Nigeria inclusive. The initiative to search for alternate innovative sources of energy to supplement or replace fossil fuels is on the rise. In recent times, rather than using fossil fuels, researchers have focused their attention upon using green methods such as plant-like seed oil and fats extracted from plants and, as a result, the most commonly used alternated fuels for now is bio-fuel (Chandrasekaran, 2016). Nearly 30 – 35 % CNSL is available in the shell where shell percentage of nut is about 67 %. A report shows that a blend of 70 % CNSL and 30% camphor Oil give results similar to diesel (Kasiraman *et al.* 2012). Another study tested commercial diesel fuel and bio-fuel from CNSL with ethanol as an additive and the result shows better performance (Velmurugan and Loganathan, 2011). Experimental Investigation of CNSL as alternative was undertaken in a work and the first trial run with a maximum of 20 % CNSL-diesel blend was successfully conducted on single cylinder of CI engine (Jindal *et al.* 2010). Engine power output and smoke emissions were found to be satisfactory even though more testing is needed. A work was also carried out to investigate the performance and emission characteristics with 0.5 %, 10 %, 15 %, 20 % and 25 % blends of Cardanol and Diesel. The report showed that up to 20 % blends of cardinal bio-fuels may be used in CI engines without any modifications (Matthew *et al.* 2005).

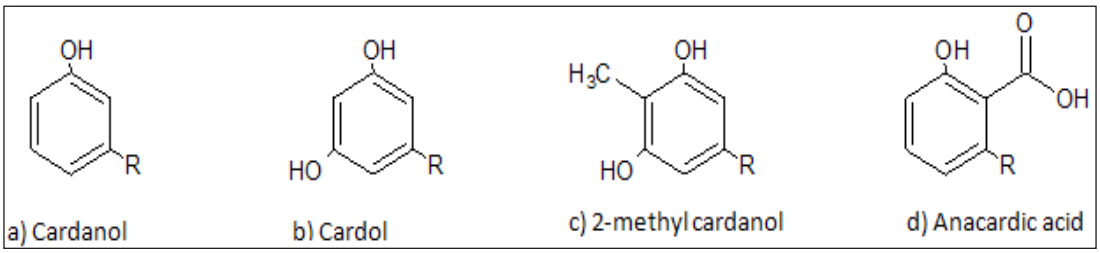

Fig. 3: Chemical constituents of technical CNSL where R is a long hydrocarbon

Therefore, the aim of this research work is to produce and stabilize natural rubber against the effect of cyclic heating using cashew nut shell liquid (technical CNSL) at varied temperature. This was achieved by roasting cashew nut shell liquid (technical CNSL) to obtain the liquid portion, treating natural rubber

to obtain CSNL treated rubber, determining the thermal stability of the treated and untreated natural rubber against thermal degradation by heating at various temperature as a function of time and finally, measuring the viscosity of the rubber solution at different periods of heating.

MATERIALS AND METHODS

Analytical reagent grade chemicals and distilled water were used throughout the study. All glassware and plastic containers were washed with detergent solution followed by soaking in 20% (v/v) nitric acid and rinsed with distilled water.

Equipment

Measuring cylinder, volumetric flask, conical flask, sieve, oven, magnetic Stirrer, digital Viscometer, locally fabricated mould with cavities and pH meter were used in this work.

Chemicals

Sulphur, mecapto benzyl thiazol disulphide (M.B.T.S), paraffin oil, n-Hexane, di-ethyl ether, stearic acid, zinc oxide, calcium carbonate and cashew Nut shell Liquid (technical CNSL) were used in this experiment.

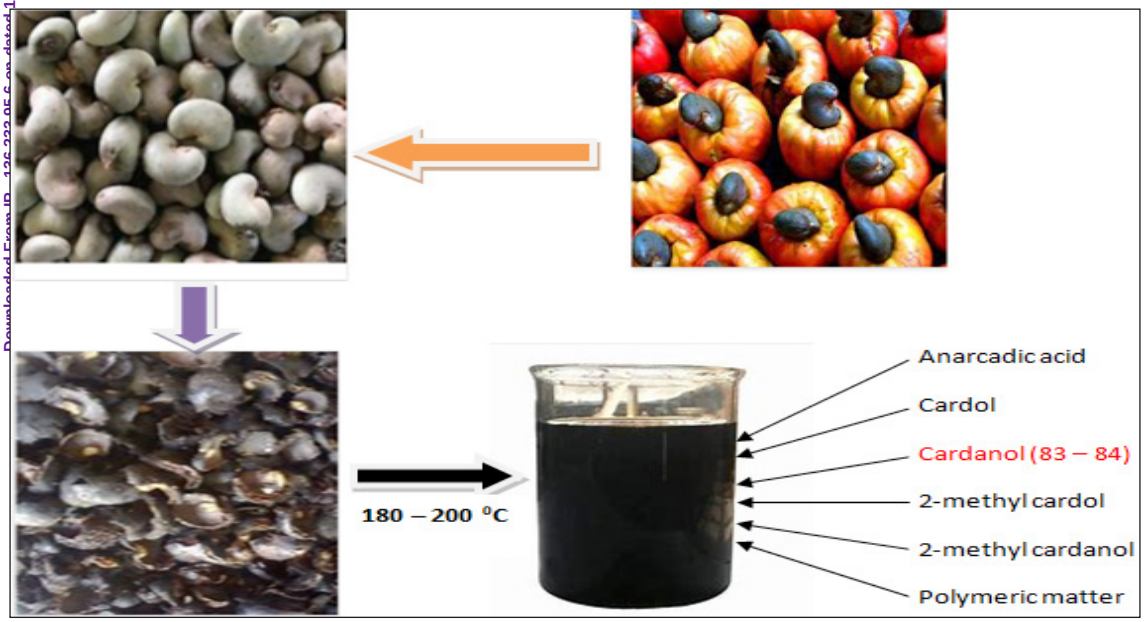

Fig. 4: Schematic diagram for preliminary processing of cashew seed to collect CNSL

Sampling of Natural Rubber and Cashew Nut

Raw Smoked Rubber was purchased from *Rubber Research Institute, Benin, South South, Nigeria* and taken to the laboratory for further treatment. Cashew seed was purchased from cashew farmers in Egdeda, Kabba, Kogi State and taken to the laboratory for further treatment.

Sample Treatment and Analyses

The purchased cashew nut samples were washed thoroughly with detergent, rinsed with distilled water to ensure high degree of purity of the product and dried under the sun for one month for easy shelling. The Shell was removed using knife (plier-like) while wearing hand gloves.

Procedure for Cyclic Heating

Two procedures are followed for cyclic heating; the first step involves the blending of raw rubber with only paraffin oil while the second step involves blending of 50 % solution of CNSL in paraffin with the raw rubber prior to heating.

Step 1: Typically, 4.00 g of raw rubber was weighed into a beaker, 16.00 mL of di-ethyl ether and 0.10 mL of paraffin was added to soften the rubber chains. After blending, the blend was allowed to dry for 12 hrs. The dried blend was placed in a 500 mL beaker and transferred into pre-heated oven at 60 ^{0}C for an hr earlier. 1.00 g of this sample was taken at the end of every four hrs of heating. A total of four samples were taken over a period of 15 hours of cyclic heating, representing samples that were heated for 3, 6, 9, 12 and15 hrs respectively. The experiment was also done at 80 and 100 ^{0}C.

Step 2: Typically, 4.00 g of raw rubber was weighed into a beaker, 16.00 mL of di-ethyl ether and 0.10 mL of 25 % of CNSL was added in paraffin oil to soften the rubber chains. After blending, the blend was allowed to dry for 12 hrs. The dried blend was placed in a 500 mL beaker and transferred into pre-heated oven at 60 ^{0}C for an hr earlier. 1.00 g of this sample was taken at the end of every four hrs of heating. A total of four samples will be taken over a period of 15 hrs of cyclic heating, representing samples that are heated for 3, 6, 9, 12 and15 hrs respectively. The experiment was also done at 80 and 100 ^{0}C.

Procedure for Moulding

There are two steps involved in this stage: rubber compounding and vulcanization of the compounded rubber.

Step 1: A 50.00 g of rubber was weighed into a container to which 200 mL di-ethyl ether added and container covered up to reduce solvent vaporization. After a period of 12 hr, 50.00 g of calcium carbonate was added and churned which followed by the addition of 2.00 g Zinc oxide and 4.00 g stearic acid which has been previously sieved and, after churning to blend, 1.00 g of M.B.T.S was added. After mixing with the rubber solution, 2.50ml of 50 % solution of CNSL in paraffin was added and blended. Finally, 1.00 g of sieved sulphur was added and blended.

The above procedure was repeated for untreated raw rubber that had been heated in a cycle of 3, 6, 9, 12 and 15 hrs respectively.

Step 2: A 6.54 g of compounded dried rubber was weighed into each of cavities in an aluminium mould and the mould and its contents were introduced into oven which had been pre-set at 150 ^{0}C over a period of 1 hr. The mould and its content was left for a period of 1 hr and 30 minutes in the oven, removed, cooled and opened to remove the cast product.

The second step was repeated for rubber samples that had been heated for 3, 6, 9, and 12 hrs which had equally been compounded as given above.

Procedure for Viscometric Measurement

A 1.25 g of cyclically heated rubber samples compounded with lipid only and dissolved in 80 mL n-hexane was made up to 100 mL in a volumetric flask. 80 mL of this was transferred into a beaker and taken to for viscometric measurement. The viscosity of the solution is then taken from the instrument in centipoises (cp) as shown in table....

RESULTS AND DISCUSSION

Extraction of Cashew Nut Shell Liquid (CNSL)

The CNSL in this study was obtained by roasting the shell (Thomas *et al.* 2017). This technical CNSL was done at the temperature between 180 to 200 ^{0}C. This method recovers 85 – 90 % of the liquid. A dark-brown liquid was obtained which research have has different percentage of components as shown in table 1 (Klimisch, 1997). The characteristics properties of the technical CNSL have been determined according to methods reported in a research work (Chaudhari *et al.* 2012) using standard equipment/ apparatus following standard methods and the results are represented in tables 2 and 3 for physical and chemical properties respectively. The viscosities study of the CNSL treated and untreated natural rubber as represented in Figs. 5, 6 and 7 show that the treated samples have higher viscosity values than the untreated ones. Fig. 6 show that at 60 ^{o}C for 15 hrs of heating, the treated samples were stable to thermal treatment while the untreated samples were relatively stable at the same temperature for up to 9 hrs but there were a drop in viscosity after the 9th hr.

Table 2: Physical properties of CNSL at room temperature

Color	Dark brown
Odor	Choke
Specific gravity	0.35
Boiling points	94.0
Refractive index	1.23
Density (g/cm3)	0.90

Table 3: Chemical properties of CNSL at room temperature

Free fatty acid	68
Acid value	1.59
Saponification value (mgKOH)	157
Iodine value (mgKOH/g)	86
Ph	5.78

This suggests that the treated with CNSL has more resistance to thermal degradation compared to the untreated one. Similar results were also obtained when the temperature was increased from 60 to 80 ^{o}C with only a point drop in the viscosity values of the treated samples while the results as represented in Fig. 6 show that there was a further drop in the viscosity values for the untreated samples. Fig. 7 also show that as the temperature was further increased to 100 ^{o}C, there were sharp drops in the viscosity

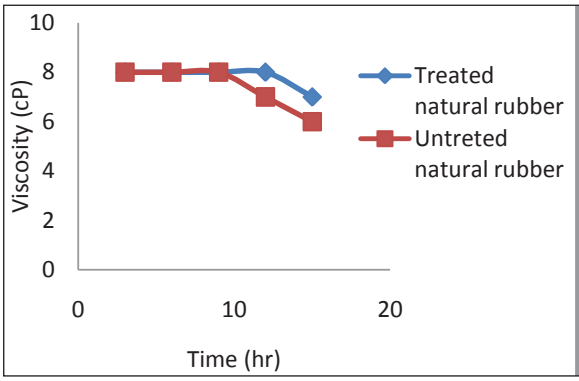

Fig. 5: Viscosities of treated natural rubber with CNSL and untreated rubber at 60 °C

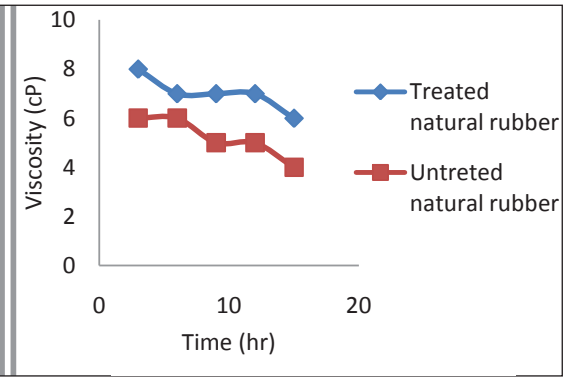

Fig. 6: Viscosities of treated natural rubber with CNSL with untreated natural rubber at 80 °C

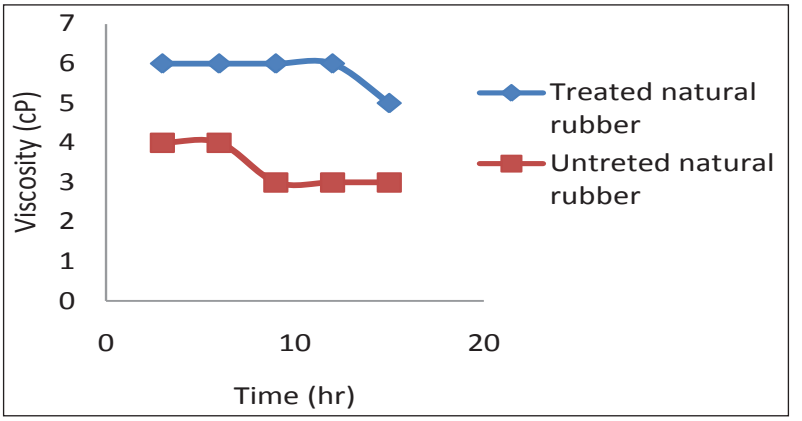

Fig. 7: Viscosities of treated natural rubber with CNSL and untreated natural rubber at 100 °C

values for the untreated samples while the treated ones remained relatively stable. Generally, viscosity decrease with increase in temperature which can be seen from the results obtained in this research work. This is because at higher temperature, particles have greater thermal energy and can easily overcome the attractive forces binding molecules together (cohesive forces between molecules decreases as temperature increases). This means that as temperature increases, there is an increase in the molecular interchange as molecules move faster at higher temperatures. Therefore, the results obtained above show that the use or incorporation of CNSL as a stabilizing agent helps in the resistance of natural rubber against thermal degradation. Analysis of CNSL show that it contains high content of unsaturated long chain phenol which suggests that its chemical structure form a cross link during vulcanization of rubber to prevent molecular flow when exposed to thermal treatment. Cardanol which is the main constituent of CNSL also has an antioxidant property due to its structure and it prevents aging in rubber materials as phenolic substances have the ability to retard oxygen adsorption. Also, larger molecules have stronger intermolecular forces such as London forces which connect them to one another with greater power to inhibit molecular flow resulting in higher viscosity. This is because viscosity depends on strength of attractive forces between

molecules as a result of composition, size and shape. Therefore, CNSL, in addition to molecular structure, also increases the molecular size and shape of natural rubber to resist molecular flow as a result of thermal treatment resulting in stability of natural rubber.

CONCLUSION

Cashew nut shell liquid (CNSL) was successfully extracted from cashew seed by roasting (technical CNSL) and the physical and chemical properties were determined. The viscosity of the technical CNSL treated natural rubber and the untreated samples were taken at different times and different temperatures for viscometric measurement. The results obtained show that the viscosities of the technical CNSL treated natural rubber at varied temperature were more stable compared to that of untreated natural rubber. Therefore, CNSL can be employed as stabilizing agent against thermal oxidation in rubber vulcanizing.

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Review Paper

AGRICULTURAL SCIENCE

Agricultural Sciences Vs. Agricultural Engineering: An Overview

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ABSTRACT

Agriculture is one of the important and valuable facets in the world as for the survival we need the foods and from agriculture it has come from. Therefore Agriculture Science is important and consider as most for the betterment of the agriculture in scientific way. Initially Agriculture considered only a tool or way for the crop development and gradually it is become a field of study. Agricultural Science is about the study of plants, pathogens, pests, herbs, chemicals and various physiological properties in better and healthy crops, plants, and vegetable products development with the context of Agriculture sustainable. Agricultural Science is considered as important and valuable applied science deals with suitable methods, tools for the development of agricultural products and foods even including animal cultivation. After the development of Agricultural Science many other allied and related branches have been developed viz. Agricultural Engineering, Agricultural Management, and Agricultural Biotechnology etc. Agricultural Engineering is focused with the designing, construction, development of the farming equipments, products, machines, tools etc. for the agricultural development and agricultural unit management. The field is dedicated also in scientific study, experiments, research, evaluation related to the Agricultural Systems. This paper is about the aspects of Agricultural Science and Agricultural Engineering including their features, attributes, natures, functions and roles and so on. Further the paper also deals with the job potentialities of the field as well.

Keywords: Agricultural Science, Agricultural Engineering, Agricultural Development, Farming, Cultivation, Agricultural Productivity

Agriculture in simple sense is the way for producing various foods and products such as corps, vegetables, plants etc. Later other components also been added into the Agriculture viz. timber, fertilizers, sugar,

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alcohol, tropical fish, wool, cotton and so on. Worldwide a majority of the workers and professionals are engaged with various types of agricultural professions. And, study considered that Internationally 11 regions are treated as agricultural productive and engaged. Once only plants and vegetables treated with the agricultural products and radically animals also treated as agricultural products with close connections with the animal sciences and husbandry. Gradually the aspects of the environment also been considered as important in agriculture including in global warming, natural disaster etc. Initially only Agricultural Science considered as important and vital as a field of study. Though, the first use of agricultural engineering was the introduction of irrigation for the large scale agriculture. Apart from these the increasing uses of the tractors and machines during the industrial revolution may be consider as important step in Agricultural Engineering began. According to the expert during the industrial revolution other devices become popular and being used viz. mechanical harvesters and planters for the cultivation of the food and crop industries etc. (Cacek *et al.* 1986; Gattinger *et al.* 2012). The increasing applications of the engineering concepts, tools, products and devices into agriculture boost in the productivity of crops and other products and a separate identical field has been started i.e. Agricultural Engineering.

Objective

The present paper entitled on 'Agricultural Sciences Vs. Agricultural Engineering: A Study' is proposed with following aim and objectives (but not limited to)—

- To know about the basics of Agricultural Science including its basics, features and characteristics.
- To learn about the Basics attributes and characteristics of the Agricultural Engineering including its emergence.
- To learn about the emerging methods of Agriculture and in the context of Agricultural Science and Agricultural Engineering.
- To know about the basic job opportunities in the field of Agricultural Engineering with reference to the areas of field of study.

Agricultural Science: Basics and Development

As an Applied Science, Agricultural Sciences is concern about various scientific principles, methods, tools etc. The field also treated as a science and art dedicated in cultivation of multiple products viz. crops, plants and even livestock and animals etc. The sedentary human civilizations enable people for the foods and survive by the initiation of the agriculture. The field of Agricultural Science though started later on but the concept regarding the agriculture started about thousands years ago and about 105,000 years ago. Furthermore the nascent farming was started before 11,500 years and gradually various kinds of animals also being part of agriculture. After that various kind of animals like pigs, sheep and cattle etc. become domesticated around 10, 000 years ago. Gradually the development of Agricultural Sciences leads the promotion in many respects. Furthermore various other branches and areas considered important and allied in Agricultural Sciences and among these important are Mechanical Engineering, Food Technology, Information and Communication Technology, Genetic Engineering, and so on. For example the field Genetic Engineering in the agricultural changed the picture traditional Agricultural in many respect

(Darnhofer *et al.* 2005; Mäder *et al.* 2002; Stockdale *et al.* 2002). Apart from the technologies the field chemistry also play a leading role in agriculture and notable changes are include—

- By the uses of the chemical fertilizer.
- In use of chemical insecticides.
- In healthy chemical fungicides.
- For the purpose of the soil makeup and development.
- Regarding the agricultural products etc.

Therefore Agricultural Science is an interdisciplinary area. And it is more than biology and combines with other areas viz. Management, Commerce and Economics and so on.

Agricultural Science: Areas and Nature

Agricultural Science is an emerging and interdisciplinary field and as far as biological areas are concerned few important are depicted in Fig. 1.

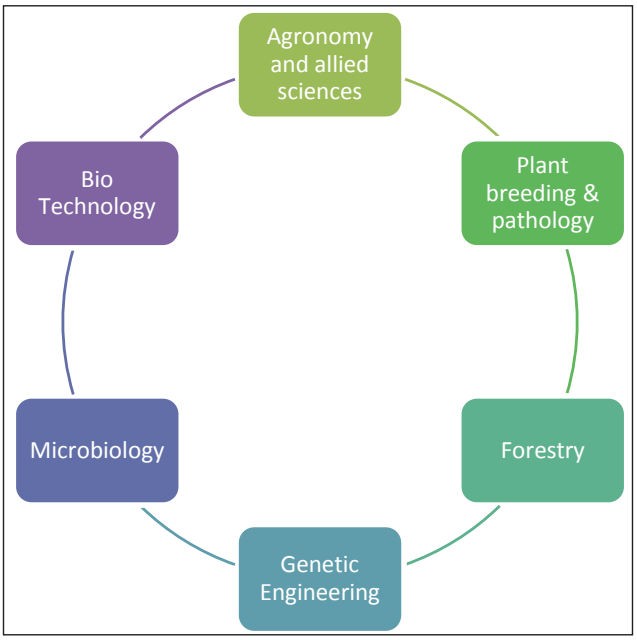

Fig. 1: The Biological areas of Agricultural Sciences and Technology

Therefore Agricultural Science is a kind of technique and procedure and gradually it has become a field of study with having various features and attributes viz.—

- Agricultural Science is a broad field of practice connected with various other fields and subjects all together.
- It is an interdisciplinary studies connected with areas from Science, Engineering, Technologies, Management and Commerce etc.

- Therefore Agricultural Sciences is a multidisciplinary one and solve the agricultural problem scientifically.
- Agricultural Science is applicable in production of the foods, agro products, animal etc. and hence it is an Applied Science.
- Apart from the biology the field Agricultural Science also connected with the economic science, social sciences for its various operations related to the agriculture.
- Emerging subjects and areas like agronomy, plant breeding, genetics, soil sciences, microbiology etc. are considered as important and valuable in proper Agricultural Science development.
- It is the study of pests and their management also for healthy and sustainable agricultural practice; moreover it doesn't deals with the environmental effects viz. waste management, horticulture, soil degradation and so on.
- Agricultural Sciences is also available as an Engineering nomenclature with Agricultural Engineering and in some context, Agricultural Science and Technology.
- The field is highly connected with Management Sciences due to agricultural systems, cultivation and products management (Hole *et al.* 2005; Ramesh *et al.* 2005; Paul *et al.* 2019).
- The latest technologies viz. Genetic Engineering, Information and Communication Technology, Nanotechnology are become important and valuable subject in this context.

Agricultural Systems become changes rapidly in recent past there are various aspects and methods in agriculture due to recent applications of the scientific methods, applications and so on viz. *Agricultural Chemistry* is responsible for use of the chemical fertilizer, insecticides including chemical fungicides in cultivation etc. Regarding the soil makeup, soil health also Agricultural Chemistry considered as important and it is treated as important in Agricultural Science. Another aspect i.e. *Green Revolution* in the Western world spread huge changes the entire world include hydroponics, plant breeding, hybridization, gene manipulation, better management of soil nutrients, and improved weed control. And here also Agricultural Science played a leading role. Though the partial role of Engineering i.e. Agricultural Engineering is also applicable in traditional Agricultural Science and changed its arena and led few other attributes viz. *Genetic engineering based Agriculture*—and it is applicable in agro products, crops, household animal product development using genetic engineering principles, tools, methods etc.

Similarly due to the Agricultural Science promotion with other technologies another system been developed viz. *Organic Agriculture* in which agricultural systems very minimum or less harmful chemical are used viz. less pesticides, fertilizers, antibiotics, growth hormones etc. and rapidly growing in modern agro production practices. *Corporate Agriculture* is farming and done by the mega corporations and large-scale farms and in this kind of agriculture corporate bodies are directly engaged in the cultivation; and here more human resources are engaged. This kind of agriculture practiced for the immediate profit also. *Vertical Farming* is another method in which corps, vegetables etc cultivated in the stacked layers, vertically (Darnhofer *et al.* 2010; Murphy *et al.* 2007; Pang and Letey, 2000). Hence, it is the solution of the space problem and in a particular area and even building floor etc. cultivation become possible. Therefore Agriculture is a broad field and not only consists with the Agricultural Science and Agricultural Engineering but also other fields, as depicted in Fig. 2.

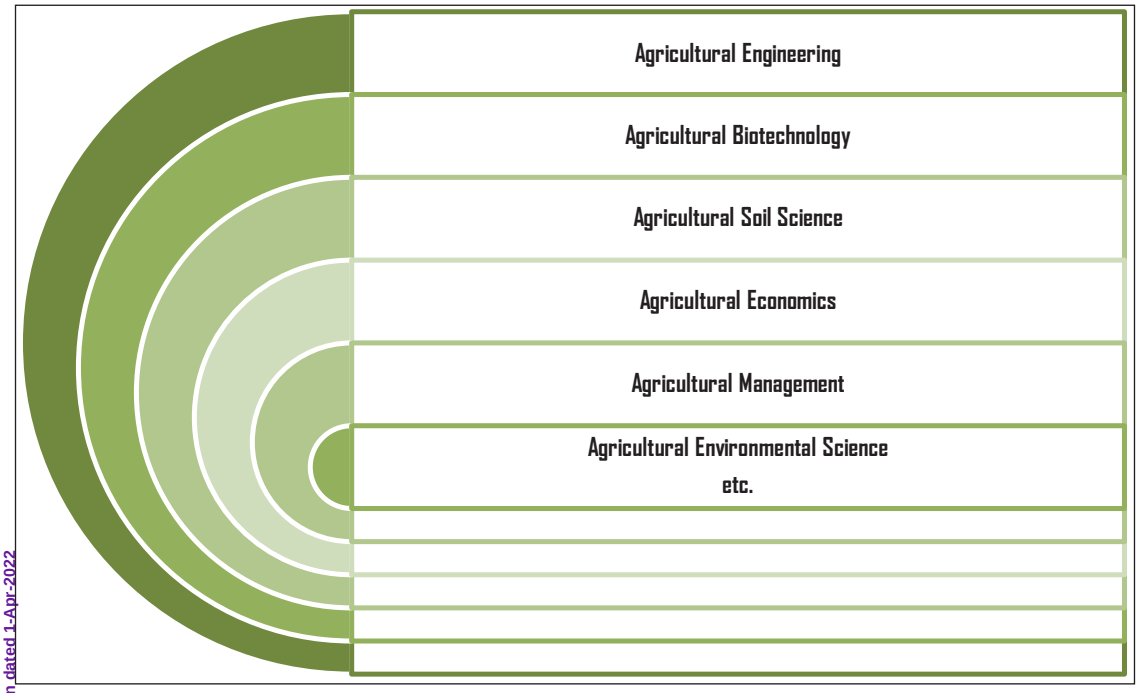

Fig. 2: The world of Agricultural Sciences

Agricultural Engineering: Need

Agricultural Engineering is a diverse field and responsible for the designing and development of the Agricultural products, tools and systems for healthy Agricultural Systems (Genius *et al.* 2006; Peigné, *et al.* 2007; Sunding and Zilberman, 2001). The following description well noted on this—

Agricultural Engineering is allied with the Agricultural Science and responsible for the designing, development of the cultivation with equipments, products, machines, and so on. It is an engineering field of farming and cultivation and dedicated in newer designing, development of the agro systems; and modification and also improvement of existing systems as well. The development of various items viz. dams, water reservoirs, agro tractors etc. Agricultural Engineering is also connected with the environmental management for healthy agricultural development including—

- ❒ Agricultural waste systems and development.
- ❒ Sustainable agricultural product designing.
- ❒ Development of Biofuels from non-food resources etc.

Agricultural Engineering is also engaged in food storage systems development, food processing system development, agro plants design and development, water and water pollution system maintenance and development etc. Agricultural Engineering is also engaged in the agricultural waste-to-energy systems and so on.

Applications and Context of Agricultural Engineering

Therefore it is a hardcore field and restricted in Agriculture and other areas and purely responsible in developing the systems, tools and products etc. viz.—

- Agricultural Engineering is responsible for the hardcore engineering solutions in respect of agriculture including irrigation, drainage systems, flood management systems, water-control mechanism and so on (Johnson *et al.* 2016; Paul, 2013; Picard and Zeng, 2005).
- Agricultural Engineering is may consider as a scientific study and research area especially for the practice in agro related fields.
- Agricultural Engineering is also engaged in designing and development of agricultural buildings required and consider as part of the agricultural systems.
- The agricultural systems including spraying, harvesting, and transportation systems, marketing system etc. may be considered as an important activity of the Agricultural Engineering.
- Agricultural Engineering needed in equipment design, farming system management regarding agriculture.
- Agricultural Engineering dedicated in the advocating, developing, implementing, mechanism development for the new ways of farming, harvesting, and storage.
- In the development of the land, water and other uses including developing healthy agricultural resource management.
- Agricultural Engineering needed in sophisticated water management and conservation systems development including in soil management, erosion control, seeding, livestock production and so on.
- Agricultural Engineering needed in animal farm management with proper mechanism following engineering and management international standards (Gunapala and Scow, 1998; Oehl *et al.* 2004; Stolze and Lampkin, 2009).

Agricultural Engineering areas are growing internationally; even other branches such as physical and chemical properties also valuable and in this regard other areas play a leading role viz. Bio Technology, Food Engineering, Environmental Engineering, etc. (Klerkx and Leeuwis, 2009; Ramesh *et al.* 2010). There are different areas of the field and some of these are depicted in Table 1.

Due to the importance of the Agricultural Engineering various job opportunities have been created such as *Agricultural Engineers* (They are responsible for the design and development of the agricultural machinery, equipments, designing of food processing units, operations etc), *Agricultural Inspector* (Such professionals are look after the aspects and issues of laws, rules and regulations related to the agricultural systems, food quality and safety. They are also look after the issues of quality standards), *Agricultural Specialist* (They are knowledgeable in agriculture and practice of the agriculture systems) *Farm Shop Manager* (Such professionals are engaged with the overall technical, and managerial aspects of the farm and agricultural units; even sometimes they do driving tractors, operating machinery, feeding livestock or spraying fields) *Food and Beverage Expert* (They are normally engaged with the monitoring of food and beverage; including they are also dedicated in recruitment, training, scheduling of the staffs), *Agronomist* (Such Professionals are dedicated in crop rotation, irrigation & drainage, planet breeding, soil science, weed control & disease & pest control), *Survey Research Agricultural Engineer* (They are primarily

engaged with the assessing the environmental impact of agricultural production, look after construction projects, solving engineering problems etc.) (Gattinger *et al.* 2012; Watson *et al.* 2002).

Table 1

Agricultural Engineering & Areas	
❖ Engineering Chemistry	❖ Kinematics and Dynamics
❖ Engineering Physics	❖ Crop Production
❖ Mathematics	❖ Hydrology
❖ Engineering Mechanics	❖ Kinematics and Dynamics
❖ Basic Electrical Engineering	❖ Electrical Machines
❖ Engineering Graphic	❖ Agriculture Engineering Structures & Rural Engineering
❖ Introduction to Computing	❖ Post-Harvest Engineering
❖ Environment and Ecology	❖ Soil and Water Conservation Engineering
❖ Engineering Thermodynamics	❖ Building Materials and Structural Design
❖ Basic Electronics	❖ Agriculture Engineering Structures and Rural Engineering
❖ Numerical Analysis & Computer Programming (C, C++)	❖ Post-Harvest Engineering
❖ Material Science	❖ Pumps Engineering & Hydraulic Control
❖ Strength of Materials	❖ Irrigation Engineering
❖ Fluid Mechanics	❖ Farm Machinery
❖ Soil Science	❖ Refrigeration and Air-conditioning
❖ Computer Programming	❖ Pumps Engineering & Hydraulic Control
❖ Soil Science Lab	❖ Instrumentation and Control Engineering in Agriculture
❖ Hydrology	
❖ Soil Mechanics	
❖ Farm Machinery / Irrigation Engineering.	

The employment opportunities in Agricultural Engineers are also changing rapidly and increasing day by day. Among the common and suitable positions few important are include (but not limited to)—

- ❒ Non-government voluntary organizations
- ❒ Department of Transportation and Agriculture
- ❒ In Tea gardens
- ❒ As Farming and Agricultural Consultants
- ❒ Agro Area development projects
- ❒ In Agricultural machinery organizations
- ❒ In Dairy industries
- ❒ In Agricultural finance organizations.
- ❒ Processing agricultural products
- ❒ In Educational Institutes including Agricultural Universities
- ❒ In Water and Environmental management and so on.

The aspects and areas of the Agricultural Engineering also changing and become closer with another area called Agricultural Information Technology, Agricultural Informatics etc. for the development of the Smart and Digital Agriculture. Therefore Agricultural Informatics may also consider as important and part of the Agricultural Engineering.

Major Findings

Therefore Agricultural Sciences is deals with the crop production process, scientific study including the pest management, soil science, agronomy, horticulture, technology and so on. Agricultural Engineering may be consider as a wider branch and following may be consider as important and valuable with following few major areas—

- Farm machinery and Power Engineering
- Irrigation Management and Engineering
- Soil and water Engineering and Management
- Harvesting and Food Processing Technology.
- Agro and Environmental Engineering etc. (Tovey, 1997; Bond and Grundy, 2001; Paul *et al.* 2015).

Thus, Agricultural Engineering deals with various equipments and systems knowledge such as irrigation, pumps, wells, tube well etc. Therefore in farm operations, Agriculture sustainable system development also this is may be offered well.

Agriculture Science is an applied sciences related to the agronomy, horticulture and soil science apiculture, entomology etc. and other biological sciences. Other Engineering Sciences such as Electrical, Civil and Mechanical Engineering etc. are very close with the Agricultural Engineering indirectly. Therefore irrigation, environmental sciences, soil and water engineering, food processing plants and food storage management etc. are the major aspects in the field. There are many relationships with Agricultural Engineering with the Agricultural Science and thus may are employed in vice versa. According to a study most of the agricultural engineers are employed with traditional hardcore engineering and it is about 17% whereas 16% are engaged with the technology management and policy and government and another 14% engaged with the food manufacturing. As per the study 13% are engaged in the construction, mining machinery. However about 6% are engaged with the education and teaching (Padel, 2001; Paul *et al.* 2015).

CONCLUSION

Agriculture Science is an applied, interdisciplinary, multidisciplinary field of study dedicated in agricultural scientific study, research and developing new methods and tools. Whereas, Agriculture Engineering is close to only hardcore engineering and designing and development of the agricultural products, systems and mechanism. However, Agricultural engineers work both indoors and outdoors and also engaged with the plans and managing projects, in agricultural settings, water management projects and so on. Both the fields are very much close with the Agricultural Informatics as well and do the plans and solve problems effectively and mutually. Both the subjects are used not only by the horticulturalists, agronomists, animal scientists, and geneticists but also policy makers etc. For the solid and sustainable development both the subjects are required. However in certain context similar and combined Agriculture Science and Engineering / or Agriculture Science and Technology nomenclature are noticeable.

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Research Case Study

AGRICULTURE & SOIL SCIENCES

Assessment of Pre-Monsoon and Monsoon Groundwater Level and Fluctuation at Regional Level in South of Haryana; Reference to Rewari District

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ABSTRACT

A present study was carried out at Dept. of Agro- Meteorology, CCS HAU Hisar to find the status of ground water in Rewari district for two decades *i.e.* from 1996-2017 With the main objective to investigate the temporal trends in annual and seasonal groundwater level and fluctuation in Rewari district. The study involved analysis of the ground water data for 20 years and mapped the changed in ground water levels between pre monsoon and monsoon seasons. The major activities in ground water fluctuation in five block of Rewari district involved the of existing data, generation of GIS database (shape files), interpolation, categorization, mapping and interpretation. Trend analysis has been done spatial analysis by Geographical Information Systems (GIS). The results indicated that a mix of negative and positive trends in the groundwater level series. Results also indicated the pre-monsoon ground water level influenced higher recharge of ground water than the total annual amount of rainfall. In pre- Monsoon rise in water level was found in north parts and decline was in south eastern parts. Study show that in Monsoon Central parts of Rewari district observed rising water table and South Eastern and North Western parts of district had declining water level from normal. The pre-monsoon season the groundwater level varied from 7.26 to 22.23 meters below ground level in depth and during the monsoon season the groundwater level was found to be from 10.46 meters to 22.23 meters bgl during year (2017).

Keywords: Groundwater level, fluctuation, pre-monsoon and monsoon, average, GIS

Water is one of the most valuable natural resources. Now a days groundwater depletion has been recognized as a global problem and the estimated that global groundwater depletion during 1900–2008 is about 4500 km^3 with the maximum rates occurring from 2000 to 2008 (Konikow, 2011). Groundwater

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use for irrigation has intensified around the world. Groundwater-based irrigation is directed to cultivated high-yielding rice during the dry season in South Asia, where India and Bangladesh represent the world's second and fourth biggest rice-producing nations, respectively (Scott and Sharma 2009; IRRI 2010).

According to Fourth Assessment Report (AR IV) of IPCC in India urbanization and industrialization, population growth and inefficient water use cases increase water shortages and its adverse impact son demand, supply and water quality which increase under changing climate (IPCC 2007). Recent studies in India reported that ground water level were decline which indicates unsustainable groundwater abstraction for both irrigation and urban water supplies. The knowledge of groundwater table fluctuations is important in agricultural lands as well as in the studies of its utilization and management levels. Groundwater is the most important water resource in semi-arid and arid regions such as Haryana. In recent years, the rapid growth of population and the increased need for water and food has put its land and water resources under severe stress. Groundwater is a dynamic natural resource. But in hard rock terrains, availability of groundwater is of limited extent. In India, 65 per cent of the total geographical area is covered by hard rock formation with low porosity (less than 5 per cent) and very low permeability (Saraf and Choudhary, 1998).

The Rewari district in Haryana state of India has agriculture based economy. The South West monsoon sets in from last week of June and withdraws in end of September, contributing about 88% of annual rainfall. July and August are the wettest months. Rest 12% rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms. Generally rainfall in the district increases from Southwest to Northeast. The mean minimum and maximum temperature in the area ranges from 1.6^{o} C to 41.0^{o} C during January and May or June respectively. Hence, availability of groundwater in good quantity is of our most importance for the area; Because of natural physiographic, high population density and intense agricultural activity, the groundwater levels and quality in the district is under high risk. Therefore, the present study was undertaken with an objective to analyse the long term changes in ground water depth and ground water fluctuation with regards to natural conditions prevailing in the area (Anonymous 2013).

Study Area

Rewari is the Southern district of Haryana state with a total geographical area of 1594 sq. km and is located between 27º46' to 28º28'N latitude and 76º15' to 76º51'E longitude. The district broadly forms part of Indo-Gangatic alluvial plain of Yamuna sub basin. It has vast alluvial and sandy tracts and interspersed strike ridges which are occasionally covered with blown sand. The district is under control of Gurgaon division and administratively divided into five blocks namely Bawal, Jatushana, Khol, Nahar and Rewari. The main water resource is district is Sahibi and Krisnavati River. In the Western part of is flat and sandy and absorbs all the rainwater. There are various other small nalas also carry rain water from the hills during Monsoon season (Anonymous 2013).

MATERIALS AND METHODS

The study is analytical in nature and based on secondary sources information. Major sources of data were ground water year data published by Central Ground Water Board and Ground Water Cell, Agricultural Department, Government of Haryana and statistical abstract of Haryana. The study was carried out for period of last 2 decades (1996-2017). Five stations/ground water observations well were selected from each

block in the Rewari district. The selected observation wells were Jatusana, Sangwari, Lukhi, Karanwas and Aulant falling in Jatusana, Rewari, Nahar, Bawal, and Khol blocks respectively. The major activities involved in this process include compilation of existing data, generation of GIS database (shape files), interpolation, categorization, mapping and interpretation.

RESULTS AND DISCUSSION

Results of the study are self-explanatory form various maps prepared in the study (Fig. 1 to 5). For better understanding the interpretation was carried out for long period average groundwater level for seasons (pre monsoon and monsoon), current groundwater level *i.e.* year 2017 and fluctuation of current groundwater level from its long period average.

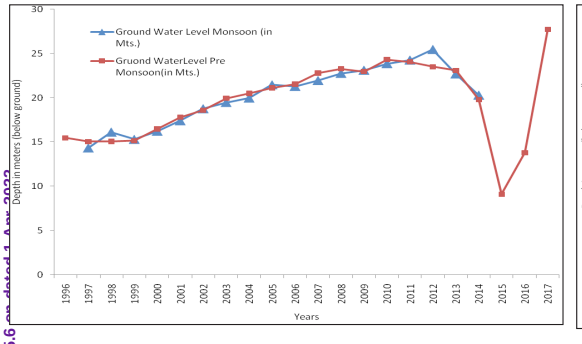

Fig. 1: Ground water level at Bawal

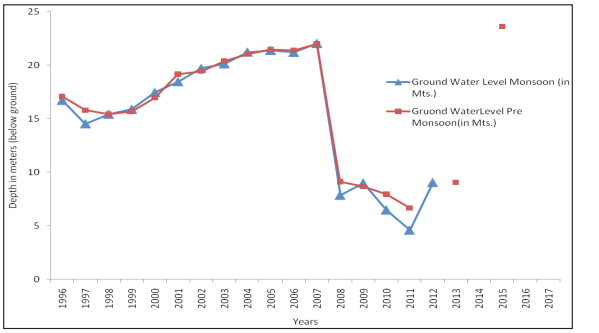

Fig. 2: Ground water levels at Jatusana

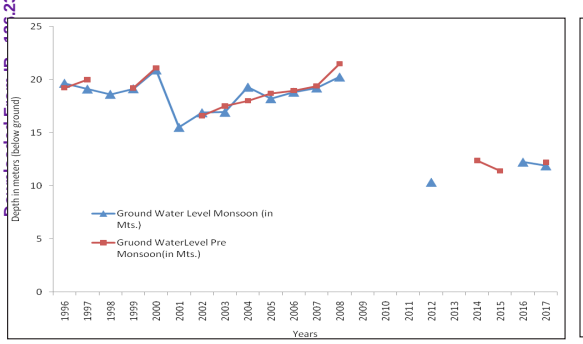

Fig. 3: Ground water levels at Khol

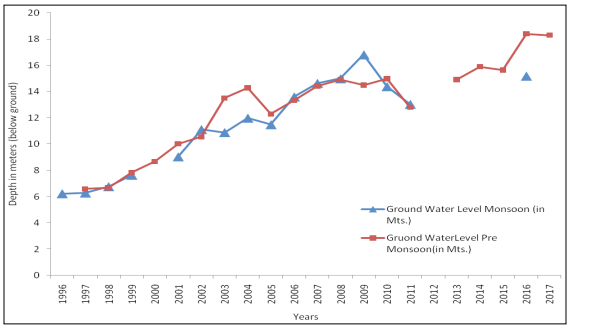

Fig. 4: Ground water levels at Nahar

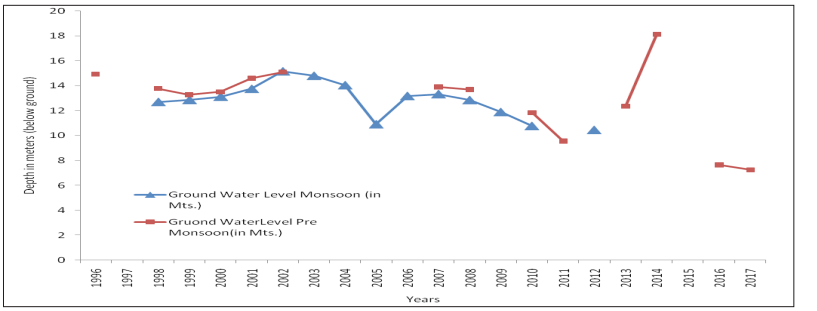

Fig. 5: Ground water levels at Rewari

Ground water status during Pre-Monsoon Period

Average of ground water level during pre-monsoon period: The long term pre-monsoon data were analysed by average the last 2 decades (1996-2017) of water level data. During pre-monsoon ground water level in the district was ranged from 12 to 19 meters below ground level (Fig. 7). Khol (Aulant), Bawal (Karanwas) and Rewari(Sangwari) was higher water table as compared to other parts of district. Southern parts of district had higher ground water level form north parts.

Ground water level in pre-monsoon 2017: During Pre-monsoon 2017 the ground water level was found form 8 m to 20 m bgl in the district (Fig. 6). In the north, ground water level was at 23 m bgl at Jatusana station. Whereas, in south-western parts it was about 8 m bgl around Sangwari and Karanwas stations of Rewari and Bawal blocks respectively.

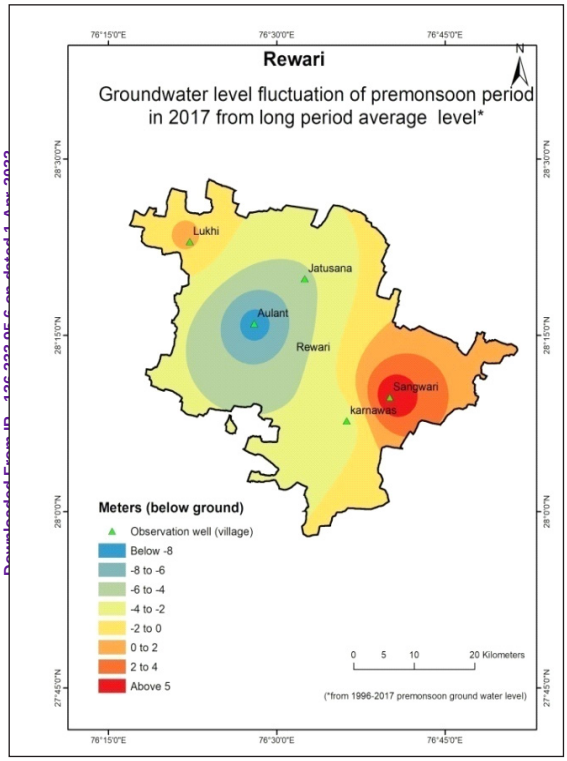

Fig. 6: Average ground water level (pre-monsoon period GW level 1996-2017)

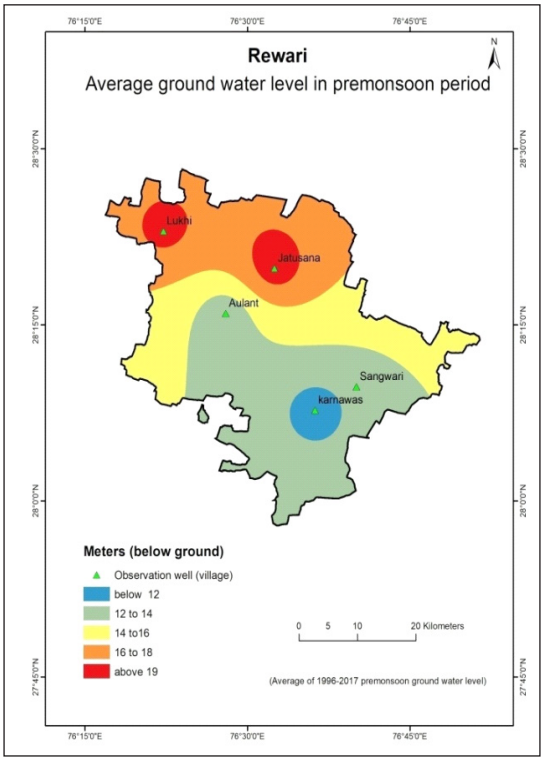

Fig.7: Ground water level during pre-monsoon 2017

Fluctuation in ground water during pre-monsoon (2017) with respect of average level:-Ground water fluctuation in pre monsoon period was found between -8 to 5 m. District observed mix pattern of rising as well as declining trends of ground water level of pre monsoon 2017 form its long time average (1996-2017). Rise in water level was found in north parts and decline was in south eastern parts. Most of the blocks had rising level as shown in map (Fig. 8).

Ground water status during Monsoon Period

Average ground water level during monsoon period:-During monsoon period, average ground water level in the district remained 10 to 16 mbelow ground. Minimum depth of Ground water was about 10 m around Bawal block (Karanwas station) in southern parts of Rewari district. In the north parts, ground water level was very low and depth was more than 18 m bgl in some parts. Overall, the Monsoon period ground water level in Rewari district was found very low (Fig. 9).

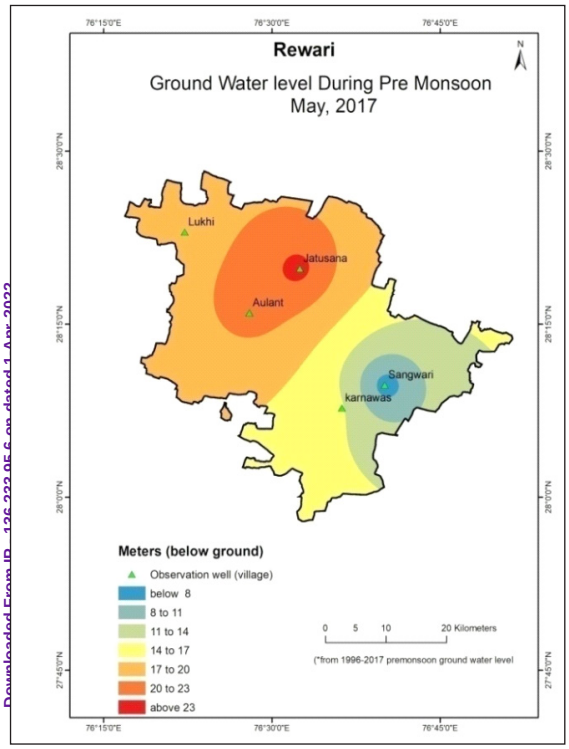

Fig. 8: fluctuations in GW level in Pre-monsoon period 2017 from average

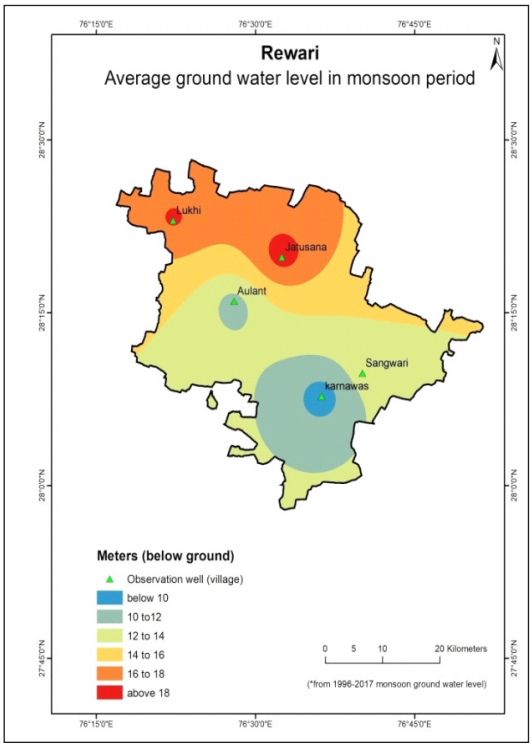

Fig. 9: Average ground water levels (monsoon period GW level 1996-2017)

Ground water level during monsoon 2017: In August, highest ground water level was found at Karanwas station at 12 m bgl. In Aulant and Jatusana ground water level was 22 m bgl. In the most of Rewari district, ground water level was found very low ranging from 12 to 20 meters or more. Southern parts of district had slightly higher water level as compared to North parts (Fig 10).

Fluctuation ground water level during monsoon (2017) with respect average level: Fluctuation of current year water (2017) level was compared with long period average water level in monsoon period for better estimation of fluctuation. Result revealed that more areas with negative values indicating the rise in water table from its normal level (Fig. 11). Central parts of Rewari district observed rising water table up to 8 meters bgl. South Eastern and north Western parts of district had declining water level of up to 2 m from normal.

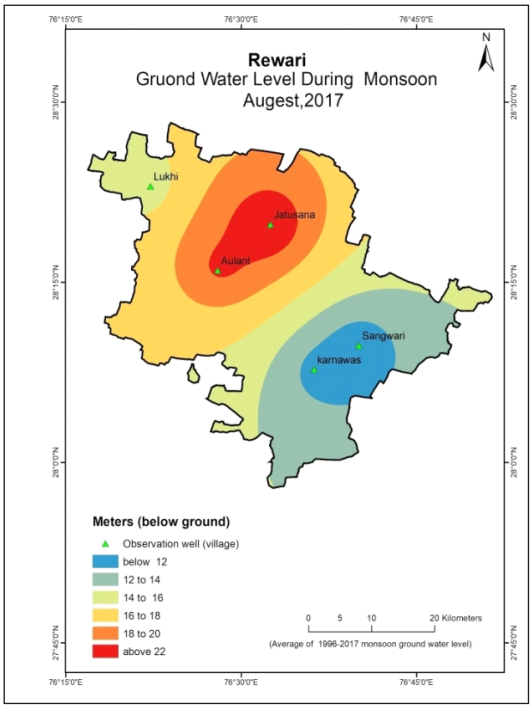

Fig. 10: Ground water level during monsoon 2017

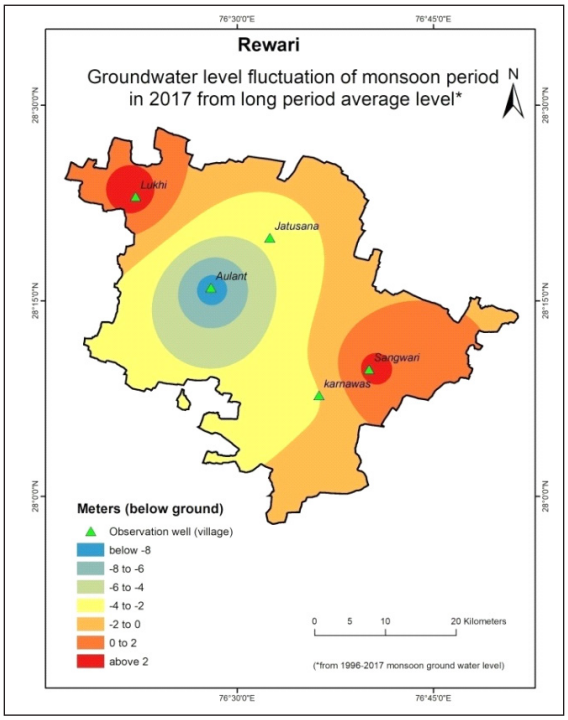

Fig. 11: Fluctuations in GW level in Monsoon period 2017 from average

Table 1: Ground Water Level (below ground water level in meters) in Rewari district

Station	Block	Groundwater Pre-Monsoon 2017 BGL (m.)	Groundwater Monsoon 2017 BGL (m.)	Groundwater Pre-Monsoon 1996-2017 BGL (m.)	Groundwater Monsoon 1996-2017 BGL (m.)	Fluctuation Pre-Monsoon BGL (m.)	Fluctuation Monsoon BGL (m.)
karnawas	Bawal	14.18	11.23	11.08	9.2	-3.1	-2.03
Jatusana	Jatusana	23.6	22.03	19.18	18.68	-4.42	-3.35
Lukhi	Nahar	18.39	15.19	18.65	18.14	0.26	2.95
Aulant	Khol	21.47	20.25	12.64	11.5	-8.83	-8.75
Sangwari	Rewari	7.26	10.46	12.82	12.85	5.56	2.39

CONCLUSION

The depth of water level ranges from 7.26 to 23.6 m (2017) bgl (below ground level) during pre-monsoon and 10.46 to 22.3m. (2017) bgl during Monsoon. The major ground water level towards the centre of the districts Jatusana and Rewari block. The Net sown area is irrigated through tube wells and canals. The minimum ground water level pre-monsoon were observed 7.26 m bgl at Rewari block and minimum ground water level monsoon were observed 10.46m bgl at Rewari during 2017. On average ground water table Northern part below normal level but in Southern part of Rewari is above normal level.

In pre- Monsoon rise in water level was found in north parts and decline was in south eastern parts. Study show that in Monsoon Central parts of Rewari district observed rising water table and South eastern and north western parts of district had declining water level from normal. During monsoon period, average ground water level in the north parts was very low in Rewari district and depth was more than 18 m bgl in some parts. During pre-monsoon ground water level in the district Khol (Aulant), Bawal (Karanwas) and Rewari (Sangwari) was higher as compared to other parts of district. Southern parts of district have higher GW level form North part of Rewari district.

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Research Case Study

APPLIED MANAGEMENT

Post COVID-19: New Era for Higher Education Systems

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ABSTRACT

On November 17, 2019, according to several sources, the first case of COVID-19 appeared in Wuhan, China, for a 55-year-old man. In addition to that, evolutionary estimates in genetic studies conducted in the early months of 2020 indicated that the Severe Acute Respiratory Syndrome (SARS) Virus most likely transfered to humans in the period between October 6th, 2019 and December 11th, 2019. The reason that led to the rapid spread of this epidemic is that its symptoms may not appear on the infected person in which, symptoms of the disease might not be shown before two weeks of the infection. The World Health Organization WHO recognized the spread of COVID-19 as a pandemic on March 11th, 2020. In the first period of the virus's spread, specifically in January and February of 2020, Italy, Iran, South Korea, Japan, and China reported increasing numbers of cases. Later that month, specifically on the 26th of February, the number of cases outside China rapidly exceeded the number of cases inside China, with the total number of cases reaching 2,790 distributed in 37 countries. During the next few days, the virus spread around the world at a steady speed, and there was no way or method to find a solution or treatment for its spread. COVID-19 had devastating effects on all living areas and on all industries, in which, it had shocking effects and frightening figures related to the movement of the global economy and companies in a manner related to the repetition and duration of closures in addition to effects beyond description related to current and future effects in connection with the methodology of higher education, universities, and educational institutions, and the related future repercussions. COVID-19 causes many symptoms such as fever, dry cough, fatigue, headache, loss of the sense of smell and taste, it also causes difficulty breathing and nasal congestion. COVID-19 is an abbreviation for coronavirus disease of 2019. Throught out this paper, The virus is mentioned as Coronavirus, COVID, and COVID-19.

Keywords: Higher education - universities - higher education institutions –accreditation - future - Coronavirus–COVID-19 - the future of higher education.

In the past months, many studies related to the effect of COVID-19 on higher education institutions and operation were published and many seminers and meetings were addressing the virus [22]. This study

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may not create new ideas or present new prospects, but rather; aims to provide general and comprehensive clarification and proposed solutions to overcome this crisis facing humanity, and mitigate its effects. This research also focuses on a very important point, which is that even if a cure and drug are found for COVID-19, humanity could be exposed in the coming years to more deadly, destructive, and impactful epidemics than COVID-19, and it must then wait for many years before the appropriate treatment appears. This research assumes the possibility of benefiting from solutions and ideas resulting from COVID-19 in the event that another similar epidemic emerges in the coming years. The author of this research *does not indicate or hint* at the emergence of other epidemics in the coming years, but rather indicates the possibility of their emergence taking into account all the data related the emergence of Corona. The study provides an explanation of the effects of Corona on the structure of international higher education systems and quality assurance bodies, its impact, the mechanism of dealing with the virus, and some steps that can be taken to mitigate the possible impact.

A number of researchers and independent sources have indicated that more than 147 million people have lost their jobs around the world due to the spread of the COVID-19 [1], which caused workers to lose an estimated $ 3.5 trillion in the wage mass, according to Guy Ryder, Director-General of the International Labor Organization ILO [51]. The level of global consumption decreased by 4.2 percent, equivalent to $ 3.8 trillion, which is equivalent to the GDP of a country such as Germany or Spain, and these financial repercussions mentioned above, in their combined cost, exceed the costs of the wars of the United States of America in each of the wars of Vietnam, Iraq, Afghanistan or the Gulf War [30][43].

Despite the very damaging effects of COVID-19 on the sector of Higher Education, the virus led to great progress of a lot of medical and scientific research related to immunity, prevention, and protection, and it has also contributed to the development of studies related to viruses, their internal structure and the method of transmission of infection. In addition, it contributed to the emergence of many types of research related to the development of human immunity and the reasons that prompted the virus to infect old people without infecting children.

Humanity has always been able to overcome the plagues it encountered and managed to survive, continue, recover, and start over and over again. Throughout history, the world has witnessed many deadly diseases and epidemics [41]some of them were epidemics confined to specific countries or geographical areas and some were global epidemics. Those epidemics claimed the lives of tens or even hundreds of millions of people [21]and caused demographic, social, and economic changes in the whole world. Pandemics changed the course of history, such as the plague that spread in the thirteen and fourteenth centuries [39], the plague of London, which appeared in 1665 [47], and caused the death of a quarter of the city's population, and smallpox, which appeared in the fifteenth century in the North and South American continents, the cholera epidemic that appeared in the nineteenth and twentieth centuries [27] that caused the death of millions, and yellow fever that appeared in the late nineteenth century [17]. The Spanish flu that appeared in 1918 [46] and also caused the death of millions, Avian influenza appeared in 2004 [25] and swine flu appeared in 2009 [52].

The history of mankind does not seem pure from epidemics and diseases, as it seems as if humanity has been for long ages in a state of war with an invisible enemy, and its fortresses or headquarters cannot be attacked or surprised or prepared for a specific war. This enemy is considered one of the most dangerous enemies at all because it attacks people without a prior warning.

Objective of the Research

This research aims to provide a brief overview of the impact of COVID-19 on the higher education sector, HEIs and higher education institutions, and the challenges that universities and accreditation assurances agencies are facing, and the measures those instititions are preparing in order to stand against this devastating epidemic that has had deadly and devastating effects in all fields, businesses and industries. The research also aims to provide a ray of hope and a candle of light to illuminate the way for all parties and stakeholders related, connected and active in the international higher education system. The research tries to present some suggestions, advice and recommendations that can serve decision-makers in the field of higher education.

Economic consequences of Covid-19

The outbreak of the epidemic caused global economic losses estimated at 50 billion USD in February 2020 alone [13]. Some studies indicate that the tourism sector alone is exposed to losses estimated at about $ 1.2 trillion, and the United Nations Conference on Trade and Development (UNCTAD) estimates that for every $ 1 million lost in international tourism receipts, a country's national income could decrease by up to $ 3 million. The matter has catastrophic effects on the employment and business sector [16]. The whole world stands in a state of fear and anxiety about the pandemic that has swept all the countries of the world and caused the world to change within the past year as if it is at a crossroads between reaching the oasis of safety or the inevitable fallout that cannot be tolerated. All researchers around the world silently watch the evolution of this virus, which appeared as we mentioned in the introduction in China, a strongly rising economic and geopolitical power that has caused heavy losses exceeding billions of dollars.

As a result of this deadly virus, all international economic development processes have stopped, international trade rates have decreased, and industries related to alternative energy have decreased as a result of the stopping of the international economy to the extent that has pushed the manufacturers of solar energy and hybrid energy systems to reduce their activity and the level of their manufacture. In addition, the virus has caused devastating consequences on the sectors of tourism, industry, energy, air transport, paper publishing sectors, book fairs, translation, and scientific research sectors, as book fairs have stopped in all countries of the world [7]. All literary and scientific seminars and meetings, all art exhibitions, poetry and artistic evenings, and theatrical performances were stopped [8], which caused great losses to these intellectual and knowledge sectors.

The pandemic has caused a painful blow to the global economy, and although the full extent of the human and economic impacts of the pandemic will not be clear for months or even years, the losses in these two areas will be great, exceeding the financial limits and reaching the knowledge and heritage of humanity as a whole. The spread of the virus in this regard could lead to political unrest in many countries that suffer mainly from financial difficulties or those countries that suffer from high levels of unemployment, which will contribute to the increase in the rates and spread of bureaucratic, dictatorial, and anti-democratic procedures. The pandemic could also contribute to the occurrence of chaos, clashes, and civil wars in those countries, and this, in turn, reduces the ability and effectiveness of countries in helping companies and the private sector at a time when these companies are in dire need of help.

In the short term, some emerging market economies and developing countries (East Asia, the Arab region, and Africa) will be the most affected economically, taking into consideration the weakness and

fragility of their health, scientific, intellectual, and educational systems. Whereas, third world countries and countries that are unable to grow during the first decade of the twenty-first century will be the direct victims of the consequences of the virus on developing and developed countries. Other countries that depend entirely on trade, tourism, or expatriate remittances from abroad, or depend on exports of raw materials or the export of valuable materials, or that mainly suffer from difficulties in financial liquidity will suffer a frightening economic recession with a devastating effect that will take a very long time for them to recover from the impacts of the virus and the burden of debts. When looking at other countries that previously suffer from debts owed to the International Monetary Fund, or those countries that have suffered from wars and conflicts (third world countries and the Arab region), we will find that the effects of the virus will be deadly so that, it will increase their financial and economic crises and lead to the financial collapse in a way similar to the economic collapse in countries such as Venezuela, and Zimbabwe [55].

As a result of this chaos, and as a result of the state of international economic fluctuation, crypto-currency prices rose in a way that they had not reached for more than 3 years, due to the instability of the prices of dollar and gold in addition to people's desire to stabilize their revenues in a way in which they could preserve their value. The repercussions will have a severe impact on the countries that are based on the export of oil derivatives, phosphates, gas, and diesel, and the reason for this is the low rates of consumption, manufacturing, and quarantine cases that are carried out by developed countries. Also, the cost of extracting, processing, transporting, and storing petroleum materials caused the rise of this problem to the point in which, the price of a barrel of oil fell below $ 0 per barrel of crude oil. This was caused by an excess of supply and a significant drop in demand due to the Corona pandemic, which is the first time that a barrel of oil has decreased to this level. If there is a sign of this action, then this means that the virus is a worrying sign of an unprecedented global energy glut, as the Coronavirus pandemic has stopped travel and curbed economic activity [54].

Direct Consequences of COVID-19

A third of the world's population faces some form of movement restriction due to the coronavirus pandemic [2]. As a result of the continuation of this crisis, many basic questions have surfaced, the most important of which is: When will life return to normal [29]? Will life return to normal [4]? What kind of economic repercussions can we expect as a result of this global epidemic[54]? Can we expect a new world order based on the new reality imposed by the virus [44]?

The spread of the virus caused a decrease in consumer spending around the world, as travel and the tourism sector in general stopped, and the industry slowed due to restrictions imposed on movement and restrictions imposed on industrial movement as a whole and Lower consumption has lowered demand [36]. Unemployment figures in the United States of America and other key indicators indicate that the impact of the current crisis was more severe than the impact of the global financial recession in 2008 [10]. Since the imposition of quarantine measures in the United States, about 22 million people have lost their jobs as a result of these very harsh measures.

Everyone agrees that the impact of the economic impact will be severe and palpable in the short term [34]. However, the most controversial question that economists ask is: What will happen to the global economy in the medium to long term [19]? Will we go through a recession followed by a sudden rebound once the virus is contained, as many expect? Or will we see a recovery at a slower pace? will the COVID-19 effect be permanent, which prompts us to adapt to it? if new waves of the virus occur during the coming

period, specifically with the advent of winter, what is the ability of global economies to withstand these devastating consequences? Will this lead to a global financial and economic downturn in 2021, which will lead to a complete halt in demand and in turn lead to international economic collapses, with their effects surpassing the recessions that occurred in 1908, the recession that followed World War I, and the financial collapse of 2008?

When we talk about Corona's losses, of course, the direct loss relates to the national income of countries and the loss of travel, airline, and transportation companies, which is a material loss whose value exceeds billions of dollars and the loss of thousands of their jobs. The long-term impact is the moral, scientific, and psychological loss of countries that have suffered from the spread of the virus. Imagine the total amount of time that humanity has paid during the past months? Imagine the millions of years in total hundreds of millions of people spent in their homes during quarantine periods? How much is the total loss of humanity during these days? The present seems mysterious to many people, students and researchers.

COVID-19 Impact on Higher Education

The Coronavirus crisis and the resulting closures affected almost every sector of the global economy, and these crises have caused some sectors to turn upside down. Perhaps one of the most directly affected by this process is the higher education sector. The outbreak of the Coronavirus epidemic has led to a major educational crisis due to the closure of schools and universities around the world and the disruption of formal education services, as more than 290 million students around the world have been directly affected [5]. Many countries have decided to close schools, colleges, universities, and all educational institutions to reduce affection rates. Here, the basic dilemma arises in the need for governments to choose between two options: either closing educational institutions, preserving lives, and limiting direct contact, or keeping them open to mitigate the devastating economic, scientific and cognitive effects resulting from their closure. It is not easy for all members and stakeholders in educational institutions to make such a decision or even transfer education to the distance education system, as it is not easy for families and students to accept that the educational process takes place entirely from home, so it is very difficult for parents and students to accept this direct transfer in the method of delivery for the education system [40].

This transformation caused a shock to the social life of children and their families. The most severe of all is the system of general examinations and the student evaluation system at the end of each semester. Will these assessments be reliable? Will it be an acceptable alternative to the traditional system? will it be a bad choice, totally unacceptable? Even more importantly, will the degree of the student who studied a complete educational program online considered acceptable? As for the labor market, will employers treat both graduates (the first graduated from an in-person program and the second from an online program) the same treatment? Due to the situation of uncertainty, we find that the questions asked to go far beyond the answers that can be provided to these questions, among them, will the student accept paying $ 73,000 to study the MBA program in the distance education system which is the same cost for the in-person program cost? Students believe that just as an e-book is about four times cheaper than a paper book, the same applies to distance education, as it should be less expensive than in-person education [33].

The most urgent question in this regard is, in the event that the prestigious universities switch to the distance education system, will they still have the distinction they had before? What will distinguish these universities when they implement the distance education system from other universities around the world? Will the ranking standards for universities around the world still carry the same previous standards

in the event that universities switch to distance education? In the coming years, we may witness a radical change in the structure and systems of higher education institutions around the world.

Coronavirus also caused unprecedented shocks in the higher education system, and more clearly, not all students, not even universities, teaching and administrative bodies, were able to change and move to this completely new system, and the students' societies did not accept this change too. It is hard to request from physics professors to prepare lectures and equations using the Zoom program because this method is completely brand new to them. It is also difficult for all students to accept this shift in which, they are requested to attend a full program of study, lectures, and register attendance while they are in front of a laptop or mobile screen. This topic needs studies in behavioral psychology and restrict student distraction as much as possible. An example of this is what will the student do during a physics lecture that he attends on the Zoom program on his mobile device if his girlfriend sends him a message? What will the professor presenting this lecture do in the event of a technical error on the laptop or in the communication program? These problems are an integral part of a complex behavioral and social system that all parties to the educational process must be prepared to accept and understand.

All members and stakeholders of the educational process must be informed that we are facing an international dilemma and a catastrophic epidemic, and we must all try to participate in accepting intermediate solutions to overcome these difficulties. In this regard, we are not proposing that what is happening is not problematic, or that dealing with this new system is very simple, as this educational system represents a new challenge for all parties. We are almost certain that educational institutions are not at all happy with this new educational system. What calms us is that we cannot do anything to change this new reality. Universities must encourage and support the teaching staff to overcome the psychological, emotional, and physical difficulties of the virus among students [26]because for those students, the future is vague, unclear, ominous, and uncertain, and there are no good predictions at all, as these students will enter the labor market that has been almost halted and stopped mainly due to the virus.

Academic Impact of COVID-19

Perhaps the direct financial impact of the losses of universities is represented in the potential income losses of foreign students who returned to their homelands after the brute application of the distance education system, and they were able to continue studying from their countries as these students provided a large and increasing share of the total income due to the high fees they pay and the increase in their numbers during the previous years. In addition, the revenues of these students help universities to finance research and studies conducted by the university. Taking into account this new reality, these universities will not be able to provide the required money that contributes to financing researches. In Britain, for example, there are more than 13 universities at risk of bankruptcy without the possibility of supporting them [9]. In addition, with the application of this new educational system, higher education institutions must provide an additional educational and scientific value that distinguishes them from other universities, and this will lead to new and severe pressures on higher education institutions that mainly suffer from the financial difficulties resulting from the virus. The new reality has also caused a difficult and suffocating negative impact on universities and educational institutions. It is well known that universities rent a number of buildings, playgrounds, swimming pools, public services centers, and car park subscriptions allowance for their students and faculty staff, and these leased properties are considered a major tributary of the tributaries that educational institutions depend on to cover their expenses. This led to educational

institutions incurring astronomical sums that were paid in advance and were not utilized at all, which caused the fiscal deficit, in addition to the financial deficit caused by students' reluctance to register at the university due to the blurry conditions caused by the epidemic.

It is also important to note that the consequences of coronavirus were not limited to losing financial returns from previously rented properties. In addition, it can be noted that the old and ancient universities need to conduct periodic maintenance for their buildings, such as colleges, institutes, and research centers [31][28]. This may seem at no cost to new universities, and those universities and HEIs established after 1975 but it might have a very large impact for universities built before 1800 such as Harvard, Oxford, and Yale in particular, and this is clearly evident in the Ivy League universities Which includes (Brown University, Columbia University, Cornell University, Dorsmith College, Harvard University, University of Pennsylvania, Princeton University, and Yale University) [53].

In addition, one of the most prominent changes that universities will face is the decline in fiscal revenues, which must act dynamically to avoid its negative effects. To clarify more, it should be noted that the number of international students in some universities exceeds 30% of the total number of students. Accordingly, what will happen to these universities when these international students return to their home countries? Certainly, this will lead to the collapse of universities' revenues and change their future plans. This will also force universities to reduce expenses, dispense with the contracts of some of its contractors, and increase registration fees for its students to cover the financial deficit. All of those factors will worsen the situation and will contribute only to the acceleration of the collapse. Suspension of the registration of international students will not only have an impact on universities alone, but will also have an impact on the sums of hard currencies that these students pay to the state treasury for housing, transportation, restaurants, hotels, swimming pools, and canteens, and all the financial costs they pay for the services they receive, which in turn, will contribute in supplying the state treasury with large sums of money.

In 2017, the amount that international students pump into the British economy was estimated at around 25 billion pounds [23]. In normal cases, universities can take advantage of internal loans from the government, but taking into account the internal financial collapse in many countries as a result of repeated closures and stoppages of industry, commerce, and tourism, this will lead us to believe that higher education institutions (and these universities) will be the biggest loser in these difficult circumstances. Higher education cannot be portrayed as a luxury that can be dispensed with. Education is our weapon to defeat Coronavirus, and if we stop education, how will we be able to confront the epidemic?

High-income private universities are expected to lose hundreds of millions of dollars in the next fiscal year, including Johns Hopkins University in The USA. As for the British universities, they will collectively face a significant financial decline, estimated at least $ 3 billion, next year due to an expected decrease in the number of students enrolled in universities, according to the British Institute for Economic Consulting in London [37]. As for Australia, its universities will lose nearly 21,000 jobs, including 7,000 jobs in the field of scientific research in universities [49]. The *most frightening possibility* for universities that cannot find a resource to cover their financial deficit is the complete closure of these universities, while other universities will be more fortunate if they can be merged with other universities [35]. How do we envision the state of merging universities with each other and what are the legal consequences of these new universities? These new universities will have to start from scratch in terms of their programs, management, and quality systems. Taking all the previous criteria into account, and with regard to the financial side of higher education institutions, Coronavirus can be viewed as a black hole that absorbs

hundreds of millions of dollars from the budget of higher education institutions and its existential impact might reach the university legal status, its existence, and personal operation. Deficit reaches 2.6 billion £ in Britain for the academic year 2020-2021 [48].

Online Teaching: The Best Available Option

Many studies have elaborated on and clarified this point, and therefore we will not talk about it in detail. Distance learning is one of the sectors that has flourished during the past years, specifically in the early 2010s, as many universities and well-established educational institutions have begun to provide their educational programs through the distance study mode, as well as many quality assurance bodies, specialized in the accreditation of distance learning programs and even, Traditional quality assurance institutions have recognized these programs that were delivered via online mode. What is important in this regard is that the educational programs that were taught in these institutions were theoretical educational programs that do not require in-person interaction with the lecturer, nor do they require any practical practice such as languages, management, business administration, literature, and journalism while the implementation of this educational system seems impossible in the study of medicine, scientific faculties, mathematics, physics, and similar educational fields. *Ludger Wößmann*, a German professor of economics at the University of Munich and director of the Ifo Center for Economic Research (Leibniz Institute for Economic Research at the University of Munich), declared that online education was not a good alternative to traditional education. He added saying that It is necessary we do everything applicable to return to traditional education as soon as possible while taking the necessary preventive measures, and if this is not possible, a complete schedule for online education must be established [32]. Even when we talk about distance education, it does not seem completely fair to all countries of the world. On the one hand, and when looking at the countries of the developed world, we find that more than 95% of their regions are equipped with the Internet and fast connection while it seems tragic in other regions and countries such as India, where about 70% of Indians living in rural areas still do not have access to digital technology [24], which makes the return of traditional education a critical issue in these areas, according to him.

With the similar mechanism and methodology of education in all universities by dealing with specific programs for teaching such as Zoom, Skype, and programs for each university, it seems that the differences between universities are diminishing and there is no longer that big difference between small universities and those advanced universities or universities with high ranking and those with a lower ranking. Universities have also begun to encourage the transition to this new educational system and direct communication with students through Telegram and WhatsApp groups and to encourage the teaching staff to share all educational resources books, and educational notes with students. Experts believe that the impact of the current COVID-19 during the years 2020 and 2021 will change the structure of higher education at the international level, and that education will be different in quantity and quality during the coming years [3].

COVID-19 Impact on Labour Market for HEIs

The controversial issue of the impact of COVID-19 on the labor market sector appears for graduates of universities and higher education institutions. The direct problem in this case for practical college students is that these students were unable to follow the practical application of theoretical skills in the

best possible way, and the economic impact that hit the economies of developing countries caused the suspension of tens of thousands of jobs and professions in addition to the suspension of trade and large companies. Regarding working online, or using the internet as a medium for work, we find that the gigantic companies (especially technology companies) monopolize most of the work and jobs, which will increase the difficulties and burdens placed on governments and countries. It is also known that five American technology companies (Google, Amazon, Facebook, Microsoft, and Uber) have liquidity exceeding $ 504 billion, which amounts to 30% of US liquidity [6]. It is possible to transfer some works and convert its work system to include work via the Internet, but this matter does not include all works and all jobs.

The direct dilemma at this point is that students in the current period are thinking about studying educational programs that do not include the direct application of practical skills, which will lead to universities focusing on some departments and neglecting other educational departments and programs. Some can suggest that the COVID-19 epidemic could end within a short period after several countries have offered several treatments. The main problem is humanity's exposure to other epidemics similar to the COVID-19 epidemic in its work and its deadly impact on humanity and at that, we will have to wait for many years before obtaining the necessary drug For the treatment of those epidemics.

COVID-19 Impact on Ensuring Quality Assurance, Accreditation and Certification of HEIs

Implementing quality assurance in the light of the presence of COVID-19 appears to be a relatively controversial issue, as it seems difficult to apply all academic standards, whether when applying programmatic or institutional accreditation to the educational institution taking into account the restrictions and barriers for the educational institution. It is also difficult for the higher educational institution, if not to say impossible, to apply all the standards regulating quality taking into account the new conditions of the epidemic, its spread, and its impact, whether on the educational institution, on students, or even on graduates. Thus, the quality assurance bodies find themselves facing a major dilemma in ensuring the safety of the standards of the educational institution without the ability to make a site visit to the institution [42]. We know for sure that the accreditation process can be conducted remotely without the necessity or the need to carry out the site-visit, but this matter does not apply to all quality assurance institutions as some of them require the visit as a basic condition for the accreditation process. Quality Assurance bodies find themselves faced with two options: either to extend accreditation to universities whose accreditation is about to expire, and in this case, the extension can be for a year or even two years depending on the extent of the virus's spread, its impact, its ability to develop itself and the human ability to deal with it, or to implement the accreditation process completely remotely, with the requirement of a site-visit to the educational institution in the event of an improvement in the health situation. Quality assurance institutions can grant conditional accreditation as an acceptable option during this difficult period.

Dark prospects and Bleak Future: Mutation of COVID-19 and the Emergence of Other Viruses

Perhaps the most controversial posibility is the fear of new epidemics emerging in the coming years so that the current decade of the twenty-first century will be the decade of biological warfare between humanity on one side, and diseases on the other side. COVID-19 appears as the first example of this pessimistic

state of humanity's ability to withstand the face of these wars and deal with them. The nightmare that we have to think about for the moment is the mutation of COVID-19 into a new virus different in its impact and effects from COVID-19. In this regard, it seems difficult to predict the future of mankind and the future of work, cultural, intellectual, and cognitive activities, in addition to the difficulties related to safety and security, and the possibilities available to preserve humanity's immunity and develop scientific studies to cope with the resulting difficulties. It also seems difficult for universities and higher education institutions to operate, bearing in mind the difficulties that could result from this pessimistic situation that causes frustration, anxiety, and fear. This also appears to be the case for quality assurance agencies. In this regard, quality assurance agencies must work to develop new, specific, and strict standards that ensure the safety of the educational process and that it meets the required standards. Humanity must prepare itself for any new virus, and doctors and scientists must prepare themselves for any event that may occur in the coming years.

Suggestions and Recommendations

1. Establishing Higher Education Emergency Response Network HEERN specialized in higher education at an international level related to providing recommendations and advice to universities and higher education institutions so that this network would have a direct role in taking the right and appropriate steps at the right time so that the losses resulting from the delay in decision-making are avoided.

International quality agencies are advised to provide a package of updates related to dealing with emergency management and dealing with ensuring the quality of education in universities by developing their educational standards and systems.

Quality assurance agencies are advised to prepare initial and temporary work plans to deal with university accreditation, either by extending the institutional accreditation of higher education institutions and suspending programmatic accreditation or by building a new system for programmatic accreditation that ensures that universities and higher education institutions apply all standards regulating accreditation.

4. Medical colleges in universities are advised tothink of conducting focused and intensive research on immunity, prevention, the structure of viruses, and the way they mutate and evolve.
5. Despite the difficult conditions that all countries of the world suffer from, governments *must* provide financial grants and pour money into universities for the purpose of conducting applied research on viruses and their mechanism. Regarding financing, we recommend that the International Monetary Fund IMF should provide financial grants to universities for the purpose of conducting studies and research focused on strengthening personal immunity.
6. Universities and higher education institutions should provide a flexible mechanism to teach their practical and theoretical curricula. In this regard, colleges can teach all theoretical programs through the distance education system. Regarding practical programs, HEIs can teach those programs following the in-person mode in the form of very small groups of 4-6 students taking the utmost safety and security and applying all prevention and triage protocols.
7. Universities must automate all educational institution resources, all documents, and supporting documents, keep backup copies of these documents and papers, and keep backup copies of these

backup copies and save them in different places. These automated resources can contribute to facilitating the accreditation of an institution's educational programs.

8. Faculties of Technology and Informatics in universities must design specialized programs to connect students with teachers and to automatically save lectures either through special Google Drive links or by direct uploading to the university's specialized channels on the Internet or on YouTube.
9. Universities must focus on information security and protecting their databases in these difficult circumstances.
10. Universities should focus on behavioral psychology to facilitate and clarify the transition to the new teaching methodology and facilitate this task for students and university faculty and administrative staff.
11. Universities must upload all practical skills on the Internet and send special fixed links to students that can be accessed 24/7.
12. We recommend employers to deal with university graduates during the past year with transparency and without discrimination because the virus has affected everyone.
13. We recommend that international NGOs support international research centers for the purpose of studying the promotion of prevention and personal protection methods.

CONCLUSION

Humanity can stand up to this virus and overcome it, just as it has overcome previous viruses during the past decades, and we, as researchers and specialists in the higher education sector, must contribute to spreading and increasing awareness to provide the best practices that can contribute to protecting the higher education sector in these difficult days.

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General Case Study

APPLIED MANAGEMENT

Why Nabors Industries (NBR) Acquired Tesco Corporation (TESO) in an All-Stock Transaction: A Case Study

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ABSTRACT

This article examines why Nabors Industries (NBR) acquired OFS (Oilfield equipment and services) industry peer Tesco (TESO). The study draws on a dataset from analysts, corporate advisers,and other sources, regarding the acquisition of Tesco by Nabors. The case study illuminates several dimensions of the Tesco & Nabors international experience before and after acquisitions and why analyst is calling the transaction a win for both buyer and seller? Is the deal also takes out a competitor in the top-drive market? Nabors Industries' $216 million acquisition of Tesco Corp is still believed as a valuable deal at the oilfield services industry.

Keywords: Acquisitions, Analyst, International experience

Nabors Industries Ltd. (NYSE: NBR) acquired all the issued and outstanding common shares of Tesco Corporation (NASDAQ: TESO), with each outstanding share of common stock of Tesco being exchanged for 0.68 common shares of Nabors. This deal created a leading rig equipment and drilling automation provider by merging Canrig, Nabors rig equipment subsidiary, with Tesco's rig equipment manufacturing, rental, and after market service business. Additionally, Tesco operated as a tubular services business in numerous key regions globally, which is believed to be benefited Nabors Drilling Solutions' operation. Nabors and Tesco contributed to a prolonged heritage of innovation, with inventions that have substantially boosted the safety and effectiveness of drilling operations over the past decade. As Nabors and Tesco implement new levels of drilling automation and analytics, this combination of Tesco and Nabors' remarkable ability and technologies reinforced their capability to increase speed and scale implementation whilst progressing to innovate.

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Transaction Highlights

- Nabors accelerates the automation and integration of pipeline services on drilling rigs and creates instant global capacity for Nabors drilling solutions [1].
- Combine a complementary portfolio of products, services, and technologies to strengthen Nabors' position as a global leader in high performance drilling equipment and software.
- Strengthening the economic position of Nabors through significant commercial and operational professional synergy, experience in Tesco management, human resources, and technology in the operation of Nabors [1].

About Nabors Industries (NBR) & Tesco Corporation

Nabors Industries Ltd. owns and operates a fleet of onshore drilling rigs. The company is a supplier of offshore drilling rigs in the United States and many international markets. The company operates in the drilling and drilling industry in four segments: drilling in the United States, drilling in Canada and international drilling and drilling services. The company offers well placement services, drilling software and demonstration equipment, drilling equipment and various technologies for the oil and gas market [2].

The company's rig drilling and installation business includes operations of onshore and onshore rigs and other rig services, including equipment manufacturing, instrumentation, and optimization software. The company offers systems and services for directional drilling and Measurement and Drilling (MWD) operations. The company also provides drilling equipment and technology, as well as well construction services [2]. Nabors has the world's largest land-based drilling fleet, with nearly 400 platforms in more than 20 countries [3].

Tesco Corporation was a world leader in the creation, manufacture, and service of technology solutions for the energy industry. The company was focused on bringing cost-effective technology to the oil and gas industry. Known worldwide as "the best way to dig the bottom" for customers, Tesco was at the forefront of research, development and commercialization of innovative products and services that reduce drilling costs and improve safety and efficiency [4].

The company's two main divisions were the Top Drive Division and its supply of tubular services. Tesco's Top Drive division used to sell and leasemost of the top drives used for drilling. The company's tubular services division provides tools and services for installing pipes and cores in new wells. These include tongs, torque monitoring services, contact testing services and hydropower plants. Tesco's largest markets include the United States, Russia, South America, and Canada [5].

Acquisition Deal: Why Nabors Planned to Acuire Tesco

The oil services and drilling industry is the worst victim of the oil crisis, with fewer mergers and acquisitions since 2014. During the recession, energy companies focused on various measures to integrate balance sheets and reduce costs. However, as crude prices partially recovered from the recession associated with the recession, energy companies entered several strategic transactions to increase their capacity. Mergers and acquisitions in the oilfield services industry are also increasing as the market stabilizes with fluctuating dynamics in the oil and gas sectors. Combined with limited organic growth, low volumes,

and low margins, drilling and oilfield services have strengthened companies [6].

Companies are focusing on accelerating mergers and acquisitions that complement their existing portfolios and help expand their capabilities and capabilities. Some M&A agreements have been signed or completed in recent months. These include the merger of Baker Hughes BHGE and General Electric, the merger of Haliburton Company HAL with Summit ESP LLC, and the merger of Tricon Well Services Limited and Canyon Services Group, Inc. The owners of the world's largest fleet of onshore drilling rigs, and Tesco, known for its technology-based solutions, want to further strengthen Nabors' position as a provider of the latest drilling news, equipment, and services [6].

The acquisition included a total share transaction of $ 215 million, with all the issued and outstanding shares of Tesco purchased by Nabors in exchange for the previous 0.68 common shares. Under this deal, Tesco's price is $ 4.62 per share, reflecting a 19% premium over Tesco's closing price of $ 3.90 on August 11, 2017. The value of the transaction is a bonus of 30% of the total business value based on Tesco's total cash balance. ... June 30, 2017. Tesco shareholders own 10% of Nabors after the closing of the transaction, which is due in the fourth quarter of 2017, based on necessary permits and satisfactory conditions. However, if the contract does not expire on February 14, 2018, Tesco will be required to pay Nabors a termination fee of $8 million [6].

The consolidation was expected to reach $20 million in the first year. Once the consolidation is fully implemented, Nabors management was expected to raise $30 million to $35 million. The rationalization of the system saves capital and the planned ramp up of housing operations could also lead to harmony. The merger was expected to close in the fourth quarter of 2017. The transaction required formal approval. Specifically, Nabors Industries acquired a 2.2% stake in US Oil Equipment & Services ETF (IEZ), which was decrease 23% compared to the previous year [7].

Nabors-Tesco Blend a Rare Win-Win in the Uniting Oil Pitch

Nabors Industries $216 million acquisition of Tesco corporation may not be a big deal, but it is important as the oilfield services industry continues to integrate. Analysts described the transaction as beneficial for both buyer and seller. According to Seaport Global Securities, Tesco's tubing business will accelerate the growth of Nabors' drilling solutions business, which will help deliver a more integrated offering and boost environmental sales when its numbers are calculated on the platform per day [8]. The deal also eliminates competitors in the top drive market, SGS said. It also said Nabors could accelerate its earnings targets by issuing shares to acquire Tesco, which was out of debt.For Tesco, the company has reached an increasingly important scale in the oil industry: "less is better." The pace of innovation in drilling seams and oilfield technology has also accelerated, and Tesco has made difficult but correct decisions to maintain its global presence and research and development efforts. According to the company, the recession is "a journey that will be increasingly difficult for companies of this size in the long term [8]."

Analysts at Tudor, Pickering, and Holt also liked the deal. This had a lot of strategic implications as it reinforced the vision of using the rig as a rig to add Nabors and provide a higher return on capital. By providing manufacturing services on a global basis as a delivery platform, the two major top drive makers, Tesco and Nabors' unit Canrigg, would further integrate the already relatively integrated product/service lines that were essential to the directional / horizontal drilling process. It is worth noting that TPH investors had "laser-focused" on Nabors' balance sheet, so it was worth noting that the deal gave

"minimal" benefit to the company's portfolio structure, proceeded all stock when Tesco was in net cash position [8].

The purchase price is slightly above Tesco's proposed transaction price of $ 4.62 per share, with a premium of 19% at the end of the transaction on Friday. According to Seaport, Nabors is rated 5.6 times the 2019 Ebitda target of 12.7 times. After considering at least 30 million estimated synergies, Tesco's implied rating drops to a more reasonable 2019 Ebitda of 4.6 times. It would be interesting to see if these cost savings were completed. Tesco's $ 25 million research and development costs and product offerings from both companies are expected to significantly overlap [8].

Strategic Benefits of Nabors Industries

Tesco is highly respected for its high-quality products and after-sales service. The acquisition of Tesco Corporation benefits mutual customers and shareholder groups. Benefits of Nabors include:

- The transaction will accelerate the integration of automated pipe services in Nabors's global presence. With Rig Operating System's largest land drilling fleet and automation functions, Nabors is in a unique position to deploy Tesco's Premium Chassis Drive Tools and Automation technology worldwide. This business will also create immediate global reach for Nabors drilling solutions [9].
- The combination of Nabors and Tesco features will make your product, service, or solution more appropriate for customers. Increased capacity helps companies improve operational efficiencies in next-generation operations, accelerate and develop new, next-generation equipment, and upgrade old parts for a new era of drilling. This elevates Nabors's position as one of the world leaders in the performance drilling equipment and software industry [9].
- The transaction also strengthens the financial position of the Nabors through additional cash flows and significant commercial and operational coordination. The first-year investment coherence is expected to reach $20 million, with a $30 million to $35 million investment coherence. The company also expects to save capital through planned construction of facilities and enclosure business [9].
- Nabors also benefit from Tesco's experienced leadership, highly skilled staff, and advanced technology [9].
- Nabors' acquisition of Tesco is seen as a "cautious next step" in building the company's technology toolbox and its aftermarket presence. The acquisition of Tesco will accelerate the company's vision of developing ultra-high rigs, enhancing the quality of NBR's premium powertrain offering and adding a case racing tool to its product portfolio [10].
- Tesco's in-house pipeline service will guarantee its status in Saudi Arabia as Tesco's leading position in the market in the Kingdom. In addition, Nabors should be able to increase the presence of the Tabo service on L48, following the established NBR standard (of which there is truly little at present) [10].
- Nabors 'acquisition of Tesco will accelerate Nabors' vision and scale, and an increase in equipment orders could increase the potential for cross-selling with Canrig [10].

Tesco Corporation 3rd Quarter 2017 Report Before Acquisation

- Estimated $1.0 million in transaction payments and $1.4 million to restructure payments in the third quarter. 64.6 million in cash and no debt at the end of the third quarter. Reported losses through US GAAP, with EPS $ (0.28) at a net loss of $13.0 million and $ (0.20) at an adjusted net loss of $9.2 million. $3.8 million fee on adjusted EPS. Adjusted EBITDA loss improved 46% to $ 2.1 million in third quarter, revenue growing slowly at 1%[11].
- Tesco Corporation improved its business, especially in Tubular services, which are benefiting from rising CDS and overseas sales in the third quarter, as well as reducing the cost of expanding US land. Despite declining sales of used record players, there has been a steady improvement in sales and EBITDA. Furthermore, although Hurricane Harvey had a small effect on our financial results (EBITDA at approximately UD $ 0.2 million), it had a significant direct impact on many of our employees [11].
- Tesco reported revenues of $40.4 million in the third quarter of 2017, or more than 1%, $30.4 million in the third quarter of 2017, and $30.4 million, or 33% more than in 2016.
- Cash and cash equivalents decreased $7.9 million between the second quarter of 2017 and September 30, 2017. $64.6 million mainly due to operating losses and $1.0 million. If working capital remains relatively stable at the end of the second quarter, a decline in working capital was expected. $4 million worth of international payments have been delayed but were expected to be paid in the fourth quarter [11].
- Inventory resulted in an increase in sales of approximately $3 million, primarily to support the expected increase in high-end record sales in the fourth quarter. Free cash flow was approximately $9.9 million in cash before revenue of approximately $1.0 million in transaction-related payments and $1.4 million in restructuring payments [11].
- Product sales in Q3 2017 include 7 new top drive units sold in Q2 2017 (4 new and 3 used) and 3 new top drive units sold in Q3 2016. This includes. In the third quarter of 2017, a new catwalk took place. At the end of the third quarter, the fleet had 113 top drives, with usage of 18 of 15% in the second quarter.
- US GAAP had an operating loss of 2.2 million to 2.3 million in the second quarter of 2017, before adjusting to the tubular services segment in the third quarter of 2017. Operating loss and operating margins were adjusted to 0, 7 million and (3) % after the third quarter, compared to 1 4.1 million and (20) % in the second quarter of 2017, respectively. The gradual improvement is mainly due to higher sales of CDs abroad and a favorable combination from the United States. - The acceleration of the ground is done by reducing costs [11].

DISCUSSION

Given the interdependence of markets for increased goods and services and increased foreign competition, we are living in times of significant change. Therefore, many companies are expanding their geographic reach. Often companies that choose to grow will want to compensate their shareholders to gain additional market share, reach new customers, make financial gains, and so on. Companies that do not grow will fail because of their losses, Consumer and market share, shareholder and share price and more. Nowadays the development in many cases includes mergers and acquisitions (M&A): In the last few years there

have been 30,000 M&A transactions, which is one transaction every 17 minutes [12]. There are several reasons for deciding to participate in M&A agreements.

Expansion: This is the main reason why visual deficiencies are determined to increase. There are two growth options: internal or organic growth and inorganic growth or external methods. According to the findings of Android, Stafford [13], with the intention of increasing the capital base of internal investment companies such as mergers and acquisitions, is expected to grow well.

- **Synergy:** Gaughan [14] argues that the term "synergy" often means physics rather than economics or finance. It refers to the type of reactions when two objects or factors act independently of each other, producing more effects than the sum of two. Simply put, synergy refers to the occurrence of 2 + 2 = 5. In a merger, this means that a business merger may be more profitable than the individual parts of a joint venture. There are two main types of synergy [15]: Operating synergy and Financial synergy.
- **Access to intangible assets:** The advent of the age of knowledge since the 1980s has brought great changes in the global and local markets. Knowledge plays an important role as a basis for the development of key organizational resources and organizational capabilities for the transformation of the industry. Today, the value of immature knowledge-based resources in the industry is increasing geometrically. Immovable assets include: Human Capital, Customer Capital, and Structural Capital [16].
- **Other Reasons:** Apart from expansion, synergy and access to intangible assets, there are many other reasons why companies are involved in mergers and acquisitions are : Horizontal and vertical integration, Improved management, Tax benefits, Changes in markets, Changes in technology and industry, Cost reduction, Extension of R&D capacities, and Obtaining a new customer base [14], [16], [17], [18]

CONCLUSION

In short, the following conclusions can be drawn:

- Mergers and acquisitions are understood as a general global trend related to the global restructuring of companies in all sectors. They are the lifeline of a healthy economy and are the primary means by which businesses benefit their owners and investors.
- From the buyer's point of view, the strategic objectives of M&A deals are primarily related to decision-making (rather than rapid growth in equity) and real estate assets: human and structural capital. And access to clients' capitalfor additional goals include consistency, currency adjustment, real estate, mismanagement issues, and tax savings. From the seller's point of view, the strategic goals of selling a business include converting shares to cash, maximizing growth, increasing prices, leaving owners, and not having access to capital.
- Contact regression analysis for four selected factors. The total number of M&A transactions, the country's GDP, incoming and outgoing FDI - showed a strong relationship. Between the number of M&A transactions and the total cost of M&A; gross domestic product; Inbound IDE. Simple linear regression analysis - concluded that Y = 972.83 + 7.13 X1 while X1 = M&A values and Y = 592.30 + 0.70 X2, while X2 = GDP can be used when planning and forecasting.

- A thorough qualitative analysis of integration and acquisition shows that most respondents also recognize the benefits of M&A transactions. Today, however, they have no plans to buy / sell the business. The paradox is that most people say that if the offer is accepted, they will not consider buying a business. If the offer is accepted, there is no clear position regarding the sale of the business.

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