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A STUDY THE RELATIONSHIPS AMONG CHEMICAL AND PHYSICAL PROPERTIES OF MILK COMPONENTS OF NATIVE AND MARAZ GOAT BREEDS

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ABSTRACT
The relationship between milk components is very important to build an equation of prediction for the future measurements. Data utilized in this study were obtained from Native and Maraz does bred at private farm in Sumail district/ Duhok governorate/ Kurdistan region of Iraq. A total of 102 samples of milk were collected directly from the udder after neglecting the first few drops to determine Physico-chemical components of milk like Protein% (P%), Fat% (F%), Lactose% (L%), Solid Non-Fat (SNF%), Freezing Point (FP), PH, Specific Gravity and ZP) by different Eko milk apparatuses. The overall means of P%, F%, L%, SNF%, FP, PH, Specific Gravity and ZP for Native goat were 3.43, 3.48, 4.33, 8.51, -0.52, 6.37, 1.03 and 2.30 while these averages for Maraz Goat were 3.48, 3.54, 4.32, 8.55, -0.53, 6.32, 1.03 and 2.32, respectively. Results revealed that it may predicting SNF % from either specific gravity or FP in Native goat milk; while it can predict SNF % from both specific gravity and FP in Maraz goat milk in addition to the possibility of prediction lactose % from specific gravity only. The highest determination coefficient (R^2) value for the best prediction equation in Native goat milk was found for predicting SNF % from simple linear regression (0.84); while the best one for the milk of Maraz was achieved for predicting SNF% from multiple linear regression (0.67).

KEYWORDS: Physico-chemical Components, Milk, Native Goat, Maraz Goat, Prediction Equations.

1. INTRODUCTION

The animal milk is complex food involving all the necessary elements that need for human and the major components of milk are casein, α-Lacto Albumin, β-Lacto Globulin, lactose, fat, vitamins and minerals (Nanakalei, 2008). The percentage of protein in goat's milk often differ according to the breed and environment, and it was 2.5 % according to the findings of (Banda et al., 2001); while the perecent was ranged from 3.6 to 3.77 % as reported by (Ciuryk et al., 2004; Alkass and Merkhan, 2013). Also this percentage was increased as the age of animal increased (Tahir et al., 2011). Fat content in goat milk often consist of triglycerides, its percentage is relatively high (6 %) according to Banda et al., (2001), but in general it ranged from 3.23 to 4.47 % (Ciappesoni et al., 2004; Merkhan and Alkass, 2013; Ciuryk et al., 2004). Lactose percentage in goat milk was ranged between 4.22 – 4.51 % (Baker, 2007; Bhosale et al., 2009; Helmut and Jassem, 2012). PH of goat's milk is relatively high (6-7) according to Jooyandeh and Aberoumard (2010); and in general it ranged between 6.45 up to 6.94 (Soryal and El Shaer, 2006; Park et al., 2007; Tahir et al., 2011; Rawya and Ahmed, 2014). The specific gravity of goat's milk is relatively low compared to milk of sheep and buffalo, which attributed to the low contents of total non-fat solid materials (Franciscis et al., 1988); however, Asif and Sumaira (2010) reported that the specific gravity had higher value (1.029); while Baker (2007) recorded the lowest one (1.026). The Electrical Conductivity (EC) of goat milk was determined as 2.85 (Tahir et al., 2011). The freezing point which often used as indicator on the supplementing water to milk and it was found as 0.52 (Park et al., 2007); such physical property of milk is affected by animal's age, and it may be has a negative value, where it ranged between (-.039 to -0.57) according to Baker (2007).

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The correlation coefficient between fat % and protein % was about 0.6 (Hadjipanayiotou, 1995), and the little is likely to be gained by using prediction equation for fat yield and protein yield; but a large correlated response for protein yield could be obtained by focusing on fat yield. Gelasakis et al., (2018) predicted the chemical composition of sheep's milk by milk yield, pH and EC using multiple linear regression, and found that the daily milk yield (DMY) was significant predictor for most milk quality traits except protein content, also pH was relatively significant predictor for some milk components; however, they concluded that the prediction equation can be regarded as a handy tool for the dairy industry to readily assess milk quality at the farm level.

Unfortunately, the references about such relationships are very rare; also there were no references related deriving prediction equations from the relationships among physical and chemical properties of goat milk.

The aim of the present investigation was to find prediction equations for SNF%, protein% or fat% (the highest cost analysis) from the percentages of moisture, pH or Freezing Point (the lowest costs analysis) for Native and Maraz does.

2. MATERIALS AND METHODS

2.1. Sample collection

A total of 102 samples of native and Maraz goat's milk were collected directly from the udder after neglecting the first few drops; in Sumeal region / Duhok governorate. The animals aged 2, 3 and 4 years old; the samples taken after birth by about 12 hours with size of 150 ml for each, using sterilized and cool boxes. The samples prepared for analysis according to (Harrigan and McCance, 1987).

2.2. Chemical-Physical analysis

The percentages of solid non-fatty matters (SNF), protein, fat and lactose were analyzed using Eko milk apparatus (Eko milk, Eko milk-M, Eko Milk-Ultra Pro.). Also, pH value was determined using the same previous apparatus, and the results confirmed according to (Al-Khouly, 1999). Milk density (Specific gravity) was measured by EKO milk too, and the results were confirmed according to (Javaid et al., 2009). The same previous apparatus was used to determine both milk freezing point (FP) and electric conductivity (EC).

2.3. Statistical analysis

The data were submitted to SPSS program (SPSS, 2019) for analyzing the descriptive statistics, correlation and simple / multiple linear regression (inter / the stepwise procedures were applied, to build a prediction equations). The following model was used for deriving the prediction equation from the multiple linear regression analysis (in case of simple linear regression, just one independent variable was used in the model):

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + e$$

where: y = dependent variable / chemical component (NFS %, fat % or crude protein %)

a = intercept (constant)

b1, b2, b3 = partial regression coefficients

x1, x2, x3 = independent variables / physical component (Z Point -ZP, pH, FP or specific gravity)

e = random error

3. RESULTS AND DISCUSSION

3.1. Native goat's milk

Table 1, shows the means and standard deviations of the physio-chemical properties of goat's milk. As shown from the mentioned table, all studied characteristics of goat's milk are relatively within normal ranges, according to literature review (Ciappesoni et al., 2004; Merkhan and Alkass, 2013; Ciuryk et al., 2004).

Table (1): Chemical and physical components of goat's milk

	Mean	Std. Deviation	N
Protein %	3.43	0.294	51
Fat %	3.48	0.239	51
Lactose %	4.33	0.145	51
SNF %	8.51	0.311	51
FP	-0.52	0.017	51
pH	6.37	0.233	51
Specific G.	1.03	0.002	51
ZP	2.30	0.228	51

However, Table 2, illustrating the correlation analysis between studied physical and chemical properties of goat's milk. It is obvious from the mentioned table that the positive significant associations are between SNF % as chemical property and specific gravity as physical property (0.92) and between SNF percent with its corresponding chemical fat % (0.31). While negative significant associations are between SNF % as chemical property and FP as physical one (-0.64); and also, between FP property with specific gravity (-0. 62), in addition to the negative significant correlation between both chemical properties (fat and lactose %) as (-0.32). However, the rest of relationships are insignificant (p>0.05) as shown in Table 2. These mean that it may build an equation to predict the chemical property (SNF %) which has high cost to be analyzed in laboratory, from both physical ones (FP and specific gravity) as low costs analysis, because the objective of this study was to derive an equation for estimating chemical component (high-cost analysis) from the physical one (low-cost analysis). The positive significant correlation means that increasing in one property cause the increasing in another; while the negative significant association means that increasing of one property cause decreasing another. The present results are disagreement with the finding that reported by (Hadjipanayiotou, 1995), who found significant correlation coefficient between fat and protein percentage in animal milk; but the same results are in agreement of the findings reported by (Gelasakis et al., 2018).

Table (2): Correlation coefficients between goat's milk components

		Protein %	FP	pH	Specific Gravity	ZP	Fat %	Lactose %
FP	Pearson Correlation	**-0.095**	1	0.089	-0.624**	0.207	-0.171	-0.219
	Sig. (2-tailed)	0.506		0.537	0.000	0.144	0.229	0.123
pH	Pearson Correlation	**0.200**	**0.089**	1	-0.047	-0.037	-0.142	0.213
	Sig. (2-tailed)	0.160	0.537		0.744	0.799	0.322	0.134
Specific Gravity	Pearson Correlation	**0.162**	**-0.624****	**-0.047**	1	0.090	0.180	0.004
	Sig. (2-tailed)	0.257	0.000	0.744		0.528	0.207	0.977
ZP	Pearson Correlation	**-0.011**	**0.207**	**-0.037**	**0.090**	1	-0.025	0.097
	Sig. (2-tailed)	0.939	0.144	0.799	0.528		0.863	0.497
Fat %	Pearson Correlation	**0.007**	**-0.171**	**-0.142**	**0.180**	**-0.025**	1	-0.320*
	Sig. (2-tailed)	0.960	0.229	0.322	0.207	0.863		0.022
Lactose %	Pearson Correlation	**0.242**	**-0.219**	**0.213**	**0.004**	**0.097**	**-0.320***	1
	Sig. (2-tailed)	0.087	0.123	0.134	0.977	0.497	0.022	
SNF%	Pearson Correlation	**0.200**	**-0.637****	**-0.047**	**0.916****	**-0.022**	**0.307***	**-0.064**
	Sig. (2-tailed)	0.159	0.000	0.745	0.000	0.880	0.028	0.656

*: significant at (p<0.05) level; ** significant at (p<0.01) level.

As illustrated from the correlation analysis (Table 2), it may apply regression analysis to build an equation for SNF from specific gravity alone or from FP alone and/or from both of them together.

Firstly, the simple linear regression for predicting SNF % from specific gravity, resulted in the following model (Table 3):

SNF % = -136.4 + 140.68 * (Specific gravity value)

With highly significant ($p<0.01$) coefficient of determination (R^2), which equal to (0.84) as shown in Table 3. This method of prediction is cheap way, due to low cost of determining the specific gravity property. The normal P-P plot of the previous analysis could be illustrated in Figure 1, which obviously explaining the prediction line. Similar significant model was obtained by (Gelasakis et al., 2018) for protein percent in sheep's milk.

Table (3): Regression coefficients, intercept (constant), coefficients of determination and prediction equations for SNF % in goat's milk

Predicted element	Predictor	Prediction equation	R^2	Sig. (P)
SNF %	SG	SNF = -136.401+ 140.678 (SG)	0.84	**
	FP	SNF = 2.284 – 11.852 (FP)	0.41	**
	SG & FP	FP was excluded	-	NS

SNF= Solid Non-Fatty matter; SG=Specific gravity; FP= Frozen point; *= significant (p<0.o5); ** = significant (p<0.01).

Secondly, the simple linear regression for predicting SNF % from FP, resulted in the following model (Table 3):

SNF % = 2.284 – 11.852 * (FP value)

With relatively high significant ($p<0.01$) coefficient of determination (R^2), which equal to (0.41) as shown in the same previous Table. This method of prediction is considered the cheapest way of estimation, due to the low cost of determining the FP property. The normal P-P plot of the last analysis could be illustrated in Figure 2, which also obviously explaining the prediction line with no extreme values.

Thirdly, the multiple linear regression for predicting SNF % from both specific gravity and FP, resulted in the same model of specific gravity (the first model of prediction), because the second factor (FP variable) was excluded from the stepwise analysis procedure (Table 3); and both factors together resulted in insignificant FP in the excluded model. The present models are similar to that reported by (Gelasakis et al., 2018).

Unfortunately, according to our search we didn't find any related review or references touch such analysis and prediction.

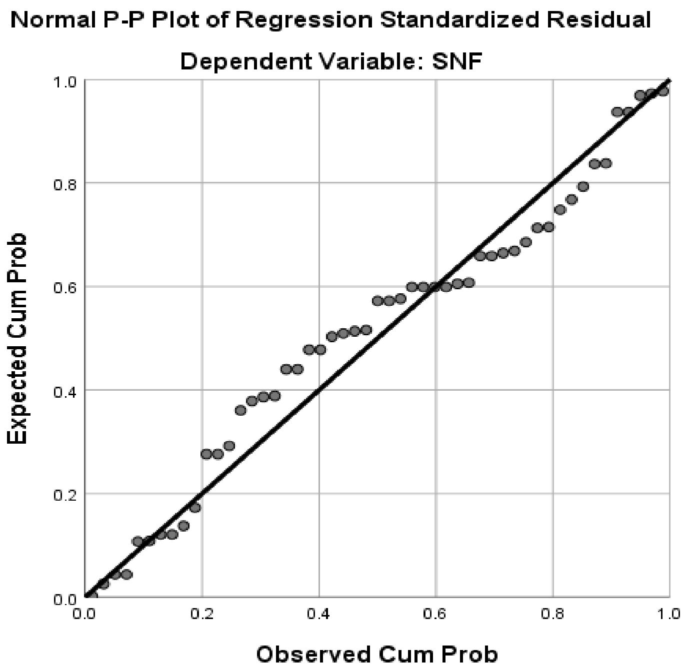

Fig. (1): The normal P-P plot of the prediction of SNF from specific gravity

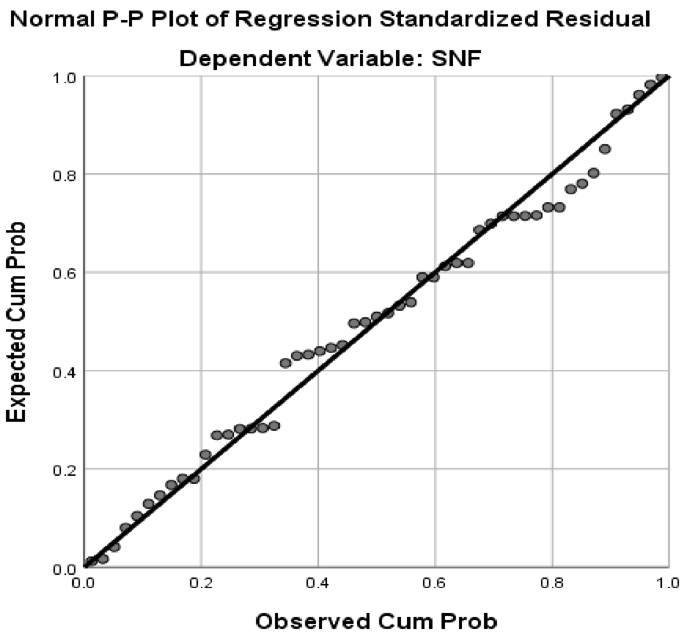

Fig. (2): The normal P-P plot of the prediction of SNF from FP

3.2. Maraz's milk

Table 4, represents the means and standard deviations of the physio-chemical properties of Maraz's milk.

Table (4): Chemical and physical components of Maraz's milk

	Mean	Std. Deviation	N
Protein %	3.4829	0.27078	51
Fat %	3.5367	0.38294	51
Lactose %	4.3202	0.13242	51
SNF %	8.5502	0.28207	51
FP	-.5265	0.01434	51
pH	6.3204	0.21384	51
Specific G.	1.0302	0.00184	51
ZP	2.3173	0.19814	51

As shown from the mentioned table, all studied characteristics of Maraz's milk are relatively within normal ranges according to review (Ciappesoni et al., 2004; Merkhan and Alkass, 2013; Ciuryk et al., 2004), and similar to the native goat one.

Moreover, Table 5, illustrating the correlation analysis between studied physical and chemical properties of Maraz's milk. It is obvious from the mentioned table that the positive high significant ($p<0.01$) associations are between specific gravity as physical analysis with lactose % as chemical property (0.41); and with SNF % as chemical one too (0.79). While the negative significant correlation coefficients are observed between both physical parameters (specific gravity with FP) which is equal to (-0.40); and also, between FP as physical property and SNF % as chemical property (-0.52). The rest properties are not associated significantly ($P>0.05$) as shown in Table 5. These finding, permit to build an equation to predict the chemical property (SNF %) which has high cost to be analyzed in laboratory, from both physical ones (FP and specific gravity) as low costs analysis (as mentioned also in previous native goat's milk samples). Also, the significant correlation coefficient between lactose percent as chemical property and specific gravity property as physical one, may result in an equation to predict the percentage of lactose percent from the value of specific gravity in Maraz milk. These results also are disagree with that obtained by (Hadjipanayiotou, 1995), but similar equation for protein have been reported by (Gelasakis et al., 2018) for sheep's milk.

Table (5): Correlation coefficients between Maraz's milk components

		Protein	FP	pH	Specific G.	ZP	Fat	Lactose	SNF
FP	Pearson Correlation	**0.129**	1	0.161	-0.401**	-0.192	0.129	-0.066	-0.524**
	Sig. (2-tailed)	0.368		0.259	0.004	0.177	0.368	0.645	0.000
pH	Pearson Correlation	**0.219**	**0.161**	1	0.104	-0.045	0.272	0.099	-0.078
	Sig. (2-tailed)	0.122	0.259		0.468	0.756	0.054	0.489	0.588
Specific Gravity	Pearson Correlation	**0.138**	**-0.401****	**0.104**	1	0.157	0.163	0.408**	0.788**
	Sig. (2-tailed)	0.334	0.004	0.468		0.273	0.254	0.003	0.000
ZP	Pearson Correlation	**0.105**	**-0.192**	**-0.045**	**0.157**	1	-0.167	0.243	-0.013
	Sig. (2-tailed)	0.465	0.177	0.756	0.273		0.243	0.086	0.926
Fat %	Pearson Correlation	**-0.062**	**0.129**	**0.272**	**0.163**	**-0.167**	1	-0.031	-0.032
	Sig. (2-tailed)	0.667	0.368	0.054	0.254	0.243		0.831	0.822
Lactose %	Pearson Correlation	**0.218**	**-0.066**	**0.099**	**0.408****	**0.243**	**-0.031**	1	0.205
	Sig. (2-tailed)	0.125	0.645	0.489	0.003	0.086	0.831		0.149
SNF %	Pearson Correlation	**0.188**	**-.524****	**-.078**	**.788****	**-.013**	**-.032**	**0.205**	1
	Sig. (2-tailed)	0.188	0.000	0.588	0.000	0.926	0.822	0.149	

**: significant at ($p<0.05$) level; ** significant at ($p<0.01$) level.*

As it is obvious from the correlation analysis (Table 5), also it may apply regression analysis to build an equation for SNF % from specific gravity alone or from FP alone and/or from both of them together; and also, it may build an equation to predict the lactose percent from the specific gravity property of Maraz's milk in the future.

Firstly, the simple linear regression for predicting SNF % from specific gravity, resulted in the following model (Table 6):

SNF % = -115.854 + 120.76 * (Specific gravity value)

This prediction equation has high significant ($p<0.01$) coefficient of determination (R^2), which equal to (0.62) as shown in Table 6. This method of prediction is considered the cheapest way for estimation, due to low-cost determination of the specific gravity property in the traditional method. The normal P-P plot of the previous analysis could be illustrated in Figure 3, which obviously explaining the prediction line with no extreme values as showed in native goat diagram.

Table (6): Regression coefficients, intercept (constant); coefficients of determination (R^2) and prediction equations for SNF % in Maraz's milk

Predicted element	Predictor	Prediction equation	R^2	Sig. (P)
SNF %	SG	SNF = -115.854 + 120.76 (SG)	0.62	**
	FP	SNF = 3.122 -10.31 (FP)	0.28	*
	SG & FP	SNF = -102.74 + 105.53 (SC) - 4.88 (FP)	0.67	**
Lactose %	SG	Lactose = -25.89 + 29.33 (SG)	0.17	*

SNF= Solid Non-Fatty matter; SG=Specific gravity; FP= Frozen point; *= significant (p<0.o5); ** = significant (p<0.01).

Secondly, the simple linear regression for predicting SNF % from FP, resulted in the following model (Table 6):

SNF % = 3.122 -10.31 * (FP value)

This last model has significant ($p<0.05$) coefficient of determination (R^2), which equal (0.28) as shown in the same previous table (Table 6). This method of prediction is considered also as the cheapest method, due to

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the lowest cost of determining for the FP property. The normal P-P plot of the last analysis could be illustrated in Figure 4, which also obviously explaining the prediction line without extreme values around the fitting line.

Thirdly, the multiple linear regression for predicting SNF % from both specific gravity and FP together, resulted in the best significant model (R^2 = 0.67) as presented in Table 6, and fitted in Figure 5; according to the following model:

SNF % = -102.735 + 105.53 * (Specific gravity value) - 4.881 * (FP value)

However, these prediction equations are similar to those obtained by (Gelasakis et al., 2018) for protein content of sheep's milk.

Also, as mentioned previously, according to our search we didn't find any related review or references touch such analysis and prediction for the studied physio-chemical properties of native Maraz milk.

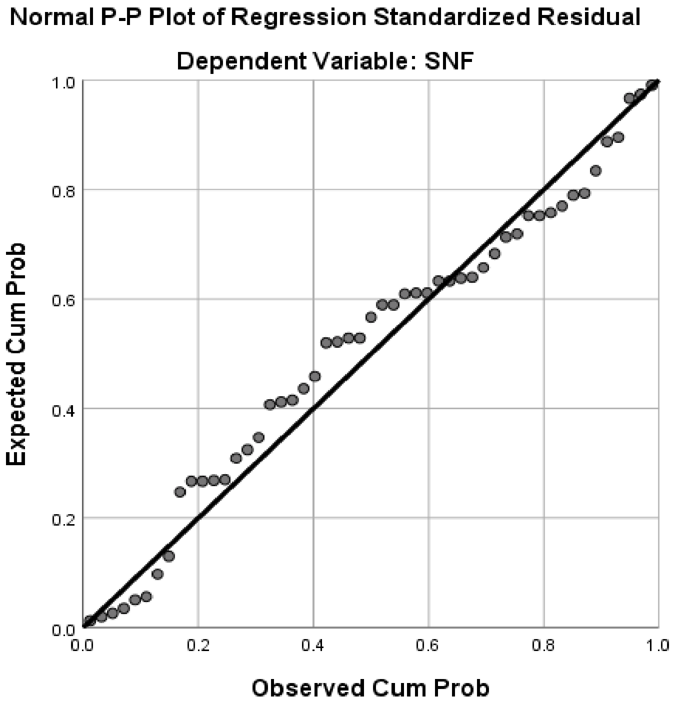

Fig. (3): The normal P-P plot of the prediction of SNF from Specific gravity in Maraz milk

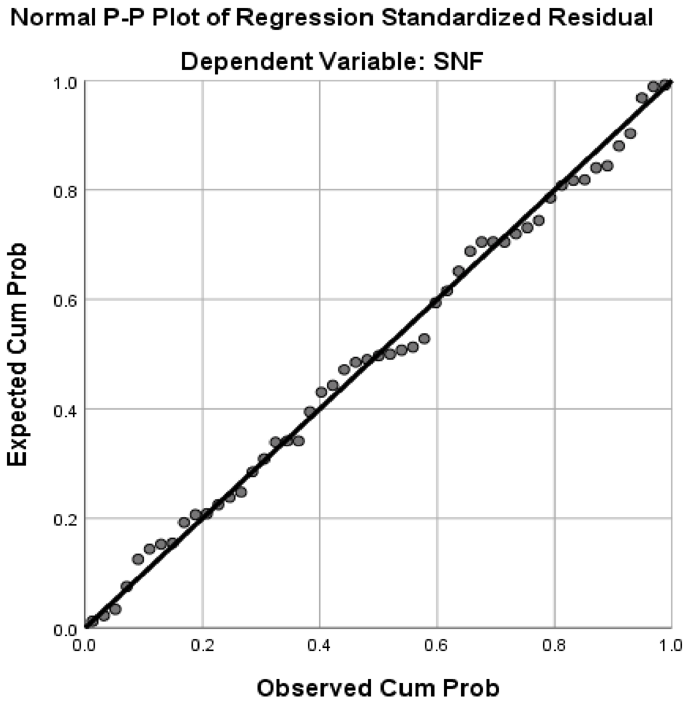

Fig. (4): The normal P-P plot of the prediction of SNF from FP in Maraz milk

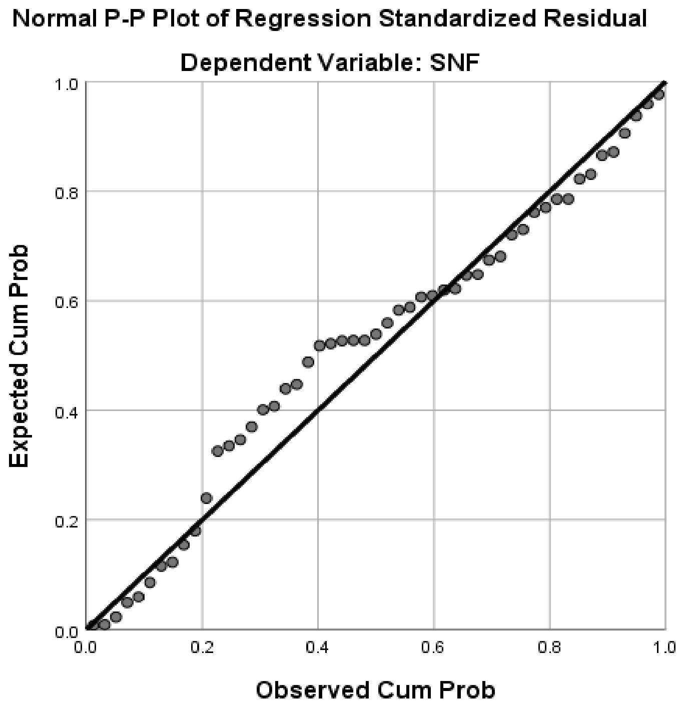

Fig. (5): The normal P-P plot of the prediction of SNF from both specific gravity and FP together in Maraz milk

Finally, the simple linear regression for predicting lactose % from gravity, resulted in a relatively weak model (R^2 = 0.17), but significant ($P<0.05$) as presented in Table 6, and fitted in Figure 6; according to the following model:

Lactose % = -25.89 + 29.33 * (Specific gravity value)

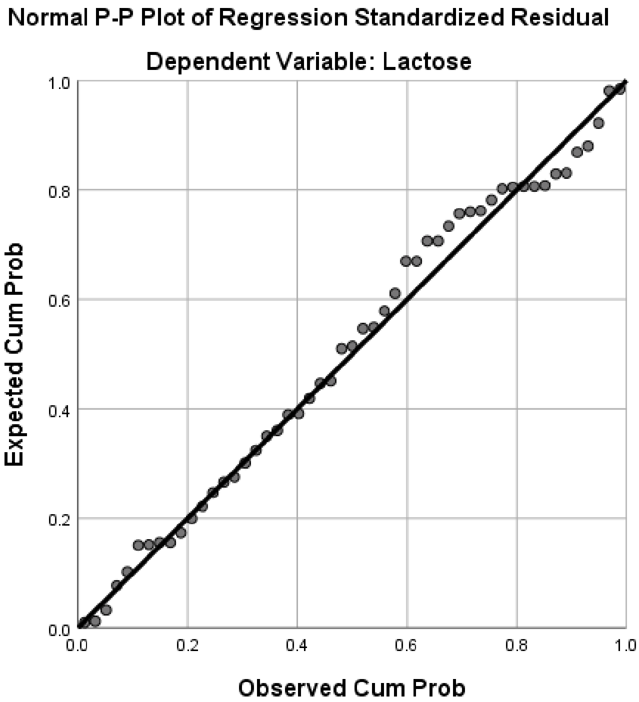

Figure 6. The normal P-P plot of the prediction of lactose from specific gravity in Maraz milk

4. CONCLUSIONS

It could be concluded from this investigation that it may predict with just SNF % as chemical property in milk of native goat, from either specific gravity or FP as physical properties; While it may predict with SNF % as chemical properties in Maraz breed, from specific gravity, FP and both of them together as physical properties, in addition to the possibility of prediction with lactose % from specific gravity in the Maraz breed.

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