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PH VALUE-MULTIFACTORIAL ANALYSIS

Mirjana Medić
Faculty of Mechanical Engineering
University of Zenica
Fakultetska 1, Zenica
Bosnia and Herzegovina

Tanja Čiča
Faculty of Science
University of Sarajevo
Zmaja od Bosne 35-37, Sarajevo
Bosnia and Herzegovina

Dr. Sabahudin Ekinović
Faculty of Mechanical Engineering
University of Zenica
Fakultetska 1, Zenica

Mr.Sc. Edin Begović
Faculty of Mechanical Engineering
University of Zenica
Fakultetska 1, Zenica

ABSTRACT
This work deals with the issue of acting pH value of water solution and shampoo in relation to changes of temperature and hardness of water and quantity of shampoo. The results of those measurements were elaborated by method of multifactorial analysis and conclusions were made with views to pH –value of skin. It is used statistical package called Data Analysis at Microsoft Excel and the results are shown in tables and graphically. We tested experimentally efficiency and effectiveness of obtained model and made conclusions.
Key words: pH value, experiment, mathematical model, statistic analyisis

1. INTRODUCTION

The beginning of each scientific work begins by choosing the subject of research and determining the goals of that research. The question is: „ *How pH value of water solution and shampoo act in relation to changes of temperature and hardness of water and quantity of shampoo?,,*

We took upper and lower level of temperature within the limits of usually temperatures of bathing (cold, hot), hardness of water within the limits of rainwater and the water from the waterworks, and quantity of shampoo of 1(ml) and 5(ml). The goal of limit values is to give answer to question, is there possibility of reaction of human skin to mentioned changes. PH –**p**otential **H**ydrogen (1909.Soren Lauritz Sorensen, Danish chemist). Acid solutions with pH less than 7, neutral solution pH= 7 and alkaline or base solutions pH more than 7. (PH is negative log of concentration of H^+ ions in some solution)

2. STATISTICAL ANALYISIS

„*Statistical data that are observed or original empirical data are data that are obtained as a result of individual perception that is observation or measurement.,,* [1] The goal of statistical analyisis is getting relevant statistical inicators that are needed for describing or in the very last case, that are needed for controling systems and phenomenon that are observed. Statistical unit is defined by content acording to its components,and acording to another criterion it is numerical,because it is expressed by quantitative characteristics of statistical unit (Table 1).

Table 1.Levels of influential factors

Level of factor	Influential factors / variable process		
	Temperature T(°C)	Hardness D (°)	Quantity of shampoo K(ml)
Upper level (+1)	34	12	5
Lower level (-1)	24	4	1

Defining of model:

$$pH = C \cdot T^x \cdot D^y \cdot K^z \qquad \ldots(1)$$

There is : pH-(Potencial Hydrogen) pH value, C-constant, x,y,z –corective coefficients, T (°C)-temperature, D(°)- hardness of water, K(ml)- quantity of shampoo. Model that is used for regressive analyisis:

$$Y=b_0+b_1X_1+b_2X_2+b_3X_3 \qquad \ldots(2)$$

First step : Testing homogenity variations of experimental results.
Calculation value - Kohran's number:

$$K_h = \frac{\max S^2{}_j}{\sum_1^N S_j^2} = \frac{0,001284}{0,0049486} = 0,2506 \qquad \ldots(3)$$

Acording to Kohran, the experiment can continue because the dispersion of lower values is homogeneous.

Second step : Calculate coefficient of regression

$$b_i = \frac{1}{N}\sum_{j=1}^{N} X_{ij}\,\bar{y}_j \quad \text{i=1,2,3(k) ; j=1,2,3,…,8 (N)} \qquad \ldots(4)$$

Mathematica l model has the following form in coded coordinates:

$$Y= 1,89672 – 0,001086\ X_1 + 0,01805631\ X_2 – 0,013785X_3 \qquad \ldots(5)$$

Third step: Checking significance of coefficient model we can conclude that $b_{0,}$ b_2 i b_3 are significant while b_1 is coefficient which doesn' t significant.

$|b_0| = |1,89672| \rangle 0,0062822,$ $\qquad |b_1| = |-0,001086484| \langle 0,0062822$

$|b_2| = |0,01805631| \rangle 0,0062822$ $\qquad |b_3| = |-0,013785284| \rangle 0,0062822$

Fourth step: Checking adequatness of mathematical model acording to Fisher's criterion. se Adequatness is defined by comparing values taht were obtained experimentally and the values taht are calculated by mathemetical model. Under the next condition:

$$S_a^2 \rangle S_y^2 \Rightarrow F_a \frac{S_a^2}{S_y^2} \le F_t(f_a, f_E) \qquad S_y^2 \rangle S_a^2 \Rightarrow F_a \frac{S_y^2}{S_a^2} \le F_t(f_a, f_E)$$

$$S_a^2 = \frac{\sum_{j=1}^{N} n(\overline{y_j^E} - \overline{y_j^R})^2}{f_a} = \frac{3 \cdot 0,000246092}{4} = 0,000184569 \qquad \ldots(6)$$

$$S_y^2 = 0,000309288 \rangle\ S_a^2 = 0,000184569 \Rightarrow$$

$$F_a = \frac{S_y^2}{S_a^2} \leq F_t(f_{F,}\, f_a) \qquad F_a = \frac{0{,}000309288}{0{,}000184569} = 1{,}6757333 \leq F_t = 3{,}01$$

$F_a \langle F_t$, obtained model describe adequately beviour of pH value in relation to defined factors. We will check coefficient of multiple regression too:

$$R = \sqrt{1 - \frac{\sum_{j=1}^{N} (y_j^E - y_j^R)^2}{\sum_{j=1}^{N} (y_j^E - \overline{y^E})^2}} = \sqrt{1 - \frac{0{,}000246092}{0{,}0043837}} = 0{,}9715256 \qquad \ldots(8)$$

Determination coefficient is indicator of quality and reliability of model: R^2=0,943862 (**94,39 %** of variability can attribute to activity of observated variables.)

Decoding of obtained regressive model we bring the model to natural coordinates.

$$ln\ pH = 1{,}8678 - 0{,}0062\ ln\ T + 0{,}033\ ln\ D - 0{,}017\ ln \qquad \ldots(9)$$

$$pH = \frac{6{,}474 \cdot D^{0{,}033}}{T^{0{,}0062} \cdot K^{0{,}017}} \qquad \ldots(10)$$

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,969449259
R Square	0,939831867
Adjusted R Square	0,894705767
Standard Error	0,054518091
Observations	8

ANOVA

	df	*SS*	*MS*	*Significance F*
Regression	3	0,185705556	0,061901852	0,006650171
Residual	4	0,011888889	0,002972222	
Total	7	0,197594444		

	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	6,606416667	0,123254902	53,5996262	6,264206198	6,948627136
X Variable 1	-0,0015	0,003855011	-0,389103931	-0,012203227	0,009203227
X Variable 2	0,030208333	0,004818764	6,268896667	0,0168293	0,043587367
X Variable 3	-0,04625	0,009637528	-4,798948483	-0,073008067	-0,019491933

3. RESULTS AND DISCUSSION

We can say for all three influential factors, temperature, hardness of water and quantity of shampoo, they belong to controlled and numerical factors. Factors that we didn't take into consideration are: contexture of shower shampoo, temperature of area in which were made measurement and time that concentration of shampoo were in water. PH value increases by increasing hardness of water (Diagram 1).That can be negative influence at keeping mild acid character of skin at showering in that conditions.

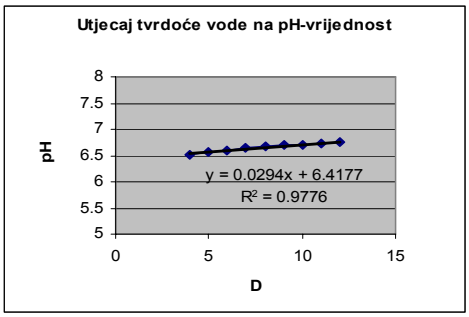

Diagram 1. Influence of rigidity of water to pH-value

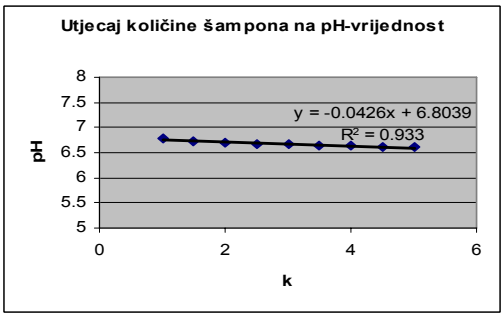

Diagram 2. Influence of quantity of shampoo to pH-value.

4. CONCLUSION

From three chosen factors which influence to pH value, significant are hardness of water and quantity of shampoo in the water, while temperature of water doesn't look important. Influence of temperature is unimportant; it is rare phenomenon at physical processes. 94,39% of variability can attribute to activity of observed variables, the rest we can attribute to temperature of area in which were made measurement and time that concentration of shampoo were in water and the type of shampoo. PH value decreases by increasing quantity of shampoo (Diagram 2), what means positive influence at keeping mild acid character of skin at showering at those characteristics of shampoo and water. That acidic characteristic of skin improves protective mechanism to potential microorganisms.*„PH can in itself be most discouraging to micro-organisms. The normal pH range of liquid shampoos is 6 to 8, although cream shampoos containing a significant amount of soap may run up to about pH 9. Within these limits the effect of pH will be felt mainly by its action on the surfactant, the antibacterial performance of anionic detergents rapidly improving as the pH moves to the acid side.“* [3]

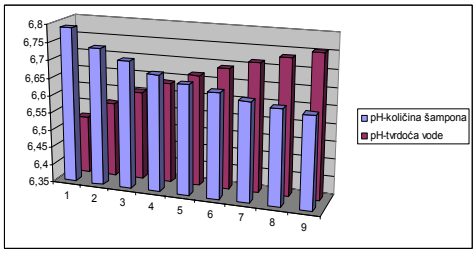

Diagram 3.Influence of quantity of shampoo and hardness of water to pH-value

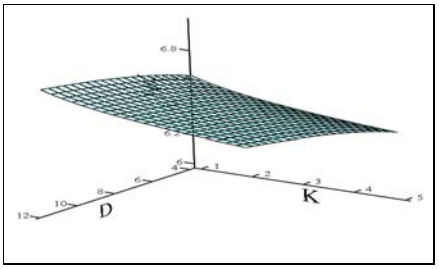

Diagram 4. Show of influence hardness of water and quantity of shampoo at 3D.

At 3D show (diagram 4) can be noticed that influences hardness of water and quantity of shampoo to pH-value are slightly expressed, but we can't ignore them.

5. REFERENCES

[1] Ekinović S.: Metode statističke analize u Microsoft Excel-u, Univerzitet u Zenici, 2008. god.
[2] Čajkovac M. : Kozmetotlogija , Naklada SLAP 2000.god
[3] D.M. Bryce and R. Smart: The Perservation of Shampoons. Preuzeto sa: http://journal.scconline.org/pdf/cc1965/cc016n04/p00187-p00201.pdf
[4] C. Couteau, M. Jadaud, F. Peigne and L.J.M. Coiffard: Influence of pH on the photodegradation kinetics under UV light of climbazole solutions. Preuzeto sa: http://analusis.edpsciences.org/articles/analusis/pdf/2000/06/2007.pdf
[5] K. Sliwa, E. Sikora, J. Ogonowski: Application of Weste Wheny in Shampoos. Preuzeto sa: http://suw.biblos.pk.edu.pl/downloadResource&mId=196529.pdf
[6] Course Management Guide. Preuzeto sa: http://www.milady.cengage.com/video/errata/cmgfeatures.pdf
[7] Savić J. i Savić M., (1990), Osnovi analitičke hemije: Klasične metode, 3. izd., Sarajevo: Svjetlost.