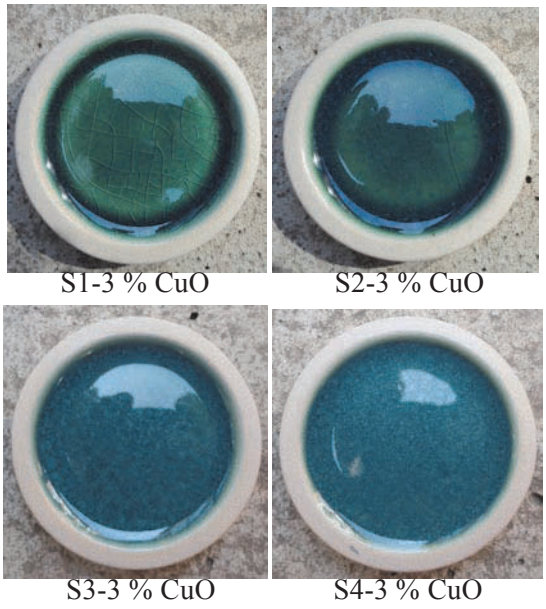
Table IV. The optical parameters of standard (S1) and perlite added glazes

Recipe No	L*	a*	b*
S1	70.81	0.88	8.95
S2	64.07	0.64	7.19
S3	69.77	1.11	10.27
S4	67.37	1.30	7.81
S5	68.44	2.49	7.81
S6	59.55	3.58	9.81

The effect of 3 % CoO and CuO incorporations into the standard and perlite added glazes on the color and texture can be seen from Figures 7 and 8. By classic cobalt blue and cupper green included the different color and texture effects were obtained depending on the glaze composition and the amount of perlite used. In the glaze contained copper oxide (S2), in which perlite was added as 20 % instead of potassium feldspar, a similar color (green copper) and surface characteristics were experienced, comparing to the standard glaze (S1). When it is added as 20 % instead of sodium feldspar (S3), the resultant color turns from green to turquoise and the textured surface forms; when it is used rather than the total amount of feldspar (40 %) (S4), the turquoise color appears. If it is used instead of ulexite (S5) at the same rate, the color is light olive green. In the boron-free glaze (S6) the use of perlite results in major dark olive-green color.

In case of cobalt oxide addition to perlite consisting glaze, S2 and S3 glazes result in a cobalt blue color relatively close to the standard one (S1). In case of using perlite instead of total amount of feldspar (40 %) dark blue color has become blue (S4). In the 30 % perlite added glaze (S5), the color is nearly black, matte dark blue. A silk matte texture in black color is observed on the surface of plate, when perlite is increased to 70 %. It is assumed that this color appears for glazes having low amount of Fe_2O_3, while ferric oxide in perlite is to be effective in the color change of glazes with copper and cobalt oxides. Tables V and VI illustrate the optical parameters of S1-S6 glazes with 3 % CuO and CoO additions.



S1-3 % CuO S2-3 % CuO

S3-3 % CuO S4-3 % CuO

S5-%3 CuO S6-%3 CuO

Figure 7. The colors of cupper oxide added glazes.

Table V. The optical parameters of the glazes with perlite and CuO

Recipe No	3 % CuO added glazes		
	L*	a*	b*
S1-3 % CuO	42.46	-10.43	5.37
S2-3 % CuO	37.35	-5.83	-2.72
S3-3 % CuO	42.05	-7.67	-1.64
S4-3 % CuO	43.16	-9.41	-1.50
S5-3 % CuO	41.29	-0.09	10.58
S6-3 % CuO	46.54	0.67	16.52

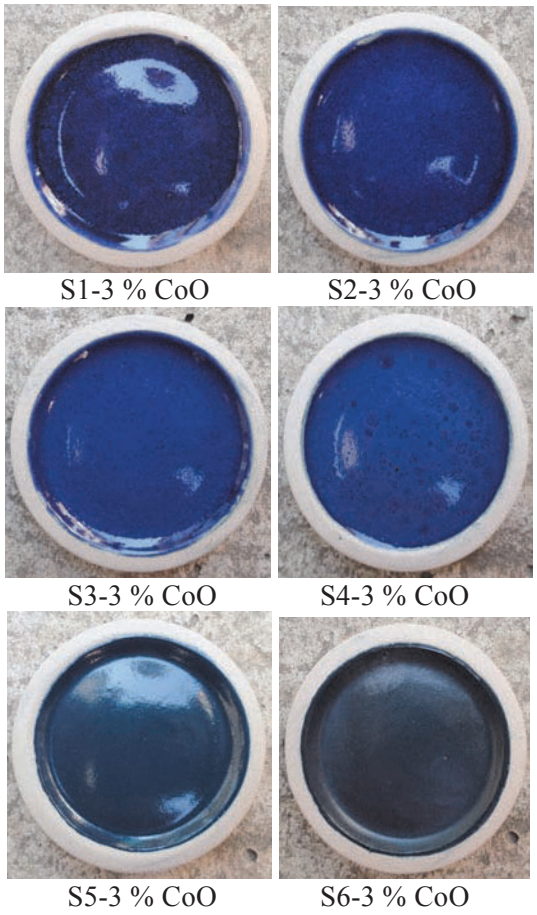


Figure 8. The colors of cobalt oxide added glazes

Table VI. The optical parameters of the glazes with perlite and CoO

Recipe No	3 % CoO added glazes		
	L*	a*	b*
S1-3 % CoO	27.35	7.39	-19.08
S2-3 % CoO	28.37	7.29	-21.29
S3-3 % CoO	31.48	5.44	-19.58
S4-3 % CoO	33.31	4.65	-18.70
S5-3 % CoO	31.21	-2.45	-5.50
S6-3 % CoO	33.24	-1.75	-2.23

4. DISCUSSION

Varying colors and surface textures were obtained by using perlite originated in Kütahya, instead of ulexite, sodium feldspar and potassium feldspar (by using perlite in equivalent amounts of the prescribed quantities of raw materials) in the alkaline and boron added standard stoneware glazes. Although there is no colorant addition in the transparent glazes, perlite concentrations more than 30 % resulted in dark buff-colored surfaces. In case of copper and cobalt oxide additions into perlite, significant differences are observed in the glaze color. Although, when cobalt oxide concentration is fixed while perlite is used instead of the entire amount of the melting agent prescribed, a matte dark blue colored black was obtained after firing at 1160 ^{o}C. If perlite is used as melting agent in the glazes, iron level in perlite plays an effective role leading to these colors. This study indicated that perlite can be utilized in the raw stoneware glazes both as colorant and melting agent. It is also suggested that perlite with high alkaline content can be used in various body and glaze recipes with using its advantages of coloring effects to create works in artistic sense.

REFERENCES

Behrens, R. (1971). *Glaze Projects, A Formulary of Leadless Glazes, A Ceramics Monthly Magazine Handbook*, the American Ceramic Society, Westerville, Ohio.

Karasu, B. (2003). Lecture Notes of Glazes and Enamels (unpublished), Anadolu University, Department of Materials Science and Engineering, Eskişehir.

Rhodes, D. (1973). *Clay and Glazes for the Potter*, Chilton Book Company, Radnor, Pennsylvania, USA, 181-182.

Sutherland, B. (2005). *Glazes from Natural Sources*, A & C Black Ltd., London, 14.

The Working Group's Report of the Mining Special Expertise Commission (2001). Industrial Raw Materials Sub-commission, Structural Materials III, (Sepiolite-Perlite-Vermiculate-Flogopit-Expanding Clays), 8th Five-Years Development Plan, Turkish Government Planning Organization (DPT): 2617-OIK: 628, Ankara.