The red variant of bambara groundnut (*Vigna subterranea*) BGN seeds from South Africa were milled, hydrated following a Central Composite Rotatable Design (CCRD) so as to optimise the BGN milk (BGNM) production process. Reduced quadratic models for pH, linear model for total solids, two factor interaction model each for hue and lightness was effective in describing the effect of hydration time and temperature. Hydration time had a significant (p < 0.05) effect on the pH, stability, lightness, chroma and total solids, and no significant effect on the hue. The effect of temperature was significant (p < 0.05) for pH, lightness, chroma and total solids. The interaction of time and temperature had a significant (p < 0.05) effect on stability, lightness, and total solids, while the effect on the pH, chroma and hue was not significant. The optimal hydration time and temperature for optimum BGNM was estimated to be 2 h at 25°C resulting in optimum BGNM with pH, hue and total solids of 6.52, 54° and 2.6%, respectively. The result demonstrated the possibility of producing BGNM using hydrated BGN flour.