SUPPLEMENTARY MATERIAL

Table S1. Analysis of variance of the chemical composition of the bread with yeast extract model

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Term | | df1 | Sum of squares | | | | |
| Protein  content | Starch  content | Fat  content | Total sugars  content | Cellulose  content |
| Yeast extract | Linear | 1 | 32.37521\* | 24.2081\* | 0.001213\* | 0.5233\* | 0.019515 |
| Quadratic | 1 | 0.94307 | 0.0166 | 0.000036 | 0.0082 | 0.000532 |
| Salt | Linear | 1 | 1.95178 | 4.5631\* | 0.000511\* | 0.2633 | 0.005016 |
| Quadratic | 1 | 0.05726 | 0.3042 | 0.000010 | 0.1028 | 0.002576 |
| Sugar | Linear | 1 | 10.20859\* | 71.0519\* | 0.004395\* | 177.2305\* | 0.091703\* |
| Quadratic | 1 | 0.03989 | 0.0086 | 0.000012 | 0.1186 | 0.000125 |
| Cross product | Yeast extract x salt | 1 | 0.28602 | 0.8075\* | 0.000013 | 0.2316 | 0.002519 |
| Yeast extract x sugar | 1 | 0.11925 | 0.0006 | 0.000019 | 0.1837 | 0.000065 |
| Salt x sugar | 1 | 0.26276 | 1.1901\* | 0.000005 | 0.0066 | 0.001184 |
| Error | Residual variance | 4 | 1.12679 | 0.2853 | 0.000166 | 0.1719 | 0.010624 |
| Total sum of squares | 13 | 45.06257 | 123.4954 | 0.008122 | 191.2990 | 0.164371 |
| *R2* | | | 0.975 | 0.998 | 0.979 | 0.999 | 0.935 |

\* Statistically significant at level of significance of *p*<0.05

1df - degrees of freedom

Table S2. Analysis of variance of the mineral content of the bread with yeast extract model

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Term | | df1 | Sum of squares | | | | |
| Zn  content | Cu  content | Mg  content | Ca  content | Fe  content |
| Yeast extract | Linear | 1 | 25.76898\* | 0.063274\* | 22768.06\* | 3788.760\* | 2.51990\* |
| Quadratic | 1 | 0.02640 | 0.000193 | 1.18 | 18.061 | 0.16242 |
| Salt | Linear | 1 | 0.87241\* | 0.044803\* | 124.65 | 11.102 | 1.00901 |
| Quadratic | 1 | 0.23647\* | 0.005363\* | 125.37 | 4.815 | 0.11274 |
| Sugar | Linear | 1 | 10.63616\* | 0.644090\* | 3064.43\* | 187.282\* | 41.12755\* |
| Quadratic | 1 | 0.00569 | 0.006569\* | 1.49 | 0.032 | 0.35739 |
| Cross product | Yeast extract x salt | 1 | 0.01551 | 0.002991 | 40.79 | 1.084 | 0.07463 |
| Yeast extract x sugar | 1 | 0.00740 | 0.000805 | 62.19 | 0.334 | 0.09288 |
| Salt x sugar | 1 | 0.01922 | 0.000158 | 6.48 | 0.072 | 0.11740 |
| Error | Residual variance | 4 | 0.03630 | 0.002289 | 117.09 | 26.472 | 0.93355 |
| Total sum of squares | 13 | 36.09714 | 0.955000 | 26361.69 | 4109.303 | 47.89944 |
| *R2* | | | 0.999 | 0.998 | 0.996 | 0.994 | 0.981 |

\* Statistically significant at level of significance of *p*<0.05

1df - degrees of freedom

Table S3. Analysis of variance of the instrumental colour and texture characteristics of the bread with yeast extract model

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Term | | df1 | Sum of squares | | | | |
| *L\** | *a\** | *b\** | *C\** | Bread crumb quality |
| Yeast extract | Linear | 1 | 21.84897\* | 6.959401\* | 17.71083\* | 7.015025\* | 0.18770 |
| Quadratic | 1 | 0.11319 | 0.004746 | 0.00251 | 0.075138 | 0.12848 |
| Salt | Linear | 1 | 2.72577 | 0.000039 | 0.68268 | 0.438322 | 0.11738 |
| Quadratic | 1 | 0.00128 | 0.036940 | 0.29949 | 0.124771 | 0.53206 |
| Sugar | Linear | 1 | 1.71788 | 0.005648 | 0.00260 | 0.003103 | 8.50540\* |
| Quadratic | 1 | 2.09682 | 0.000201 | 0.00000 | 0.160561 | 0.85973 |
| Cross product | Yeast extract x salt | 1 | 1.58984 | 0.000296 | 0.60620 | 0.141092 | 0.13764 |
| Yeast extract x sugar | 1 | 0.68667 | 0.001088 | 0.12094 | 0.091165 | 2.16433 |
| Salt x sugar | 1 | 0.02587 | 0.001894 | 0.00473 | 0.005933 | 0.08232 |
| Error | Residual variance | 4 | 2.21420 | 0.158037 | 0.78272 | 0.268628 | 1.23756 |
| Total sum of squares | 13 | 34.92969 | 7.532743 | 22.23944 | 8.859743 | 18.26804 |
| *R2* | | | 0.937 | 0.979 | 0.965 | 0.969 | 0.932 |

\* Statistically significant at level of significance of *p*<0.05

1df - degrees of freedom

Table S4. Analysis of variance of the sensory characteristics of the bread with yeast extract model

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Term | | | df1 | | Sum of squares | | | | | | | | | | | | | | |
| Appearance | | | | | | | Taste | | | | | | | |
| Characteristic | Crust colour intensity | | Crumb colour intensity | | Colour uniformity | | Characteristic | | Sweet | | Sour | | Salty | |
| Yeast extract | Linear | | 1 | | 6.689\* | 47.89\* | | 28.66\* | | 0.25\* | | 18.43\* | | 107.73\* | | 75.85\* | | 10.66\* | |
| Quadratic | | 1 | | 0.01 | 0.15 | | 1.39 | | 0.08 | | 1.23 | | 6.99\* | | 1.62 | | 0.01 | |
| Salt | Linear | | 1 | | 2.24\* | 4.56 | | 3.11 | | 0.08 | | 0.85 | | 0.78 | | 1.54 | | 20.55\* | |
| Quadratic | | 1 | | 0.50 | 2.01 | | 0.26 | | 0.00 | | 0.00 | | 1.33\* | | 0.39 | | 0.37 | |
| Sugar | Linear | | 1 | | 1.83 | 7.18 | | 1.49 | | 0.03 | | 6.34\* | | 0.15 | | 0.04 | | 0.58 | |
| Quadratic | | 1 | | 0.05 | 0.00 | | 0.03 | | 0.02 | | 0.45 | | 0.77 | | 0.50 | | 0.00 | |
| Cross product | Yeast extract x salt | | 1 | | 0.06 | 2.51 | | 0.24 | | 0.18 | | 2.57 | | 0.01 | | 0.00 | | 0.40 | |
| Yeast extract x sugar | | 1 | | 0.03 | 0.07 | | 0.16 | | 0.03 | | 7.62\* | | 0.83 | | 0.00 | | 2.83\* | |
| Salt x sugar | | 1 | | 0.24 | 0.33 | | 0.49 | | 0.02 | | 0.12 | | 0.45 | | 0.32 | | 0.02 | |
| Error | Residual variance | | 4 | | 0.96 | 6.13 | | 4.03 | | 0.10 | | 2.85 | | 0.57 | | 2.97 | | 1.25 | |
| Total sum of squares | | 13 | | 15.10 | 83.54 | | 45.98 | | 0.84 | | 59.56 | | 131.99 | | 89.65 | | 39.29 | |
| *R2* | | | | | 0.936 | 0.926 | | 0.912 | | 0.875 | | 0.952 | | 0.996 | | 0.967 | | 0.968 | |
|  | | | | | Aroma | | | | | | | Texture | | | | | | | |
| Term | | df1 | | | Characteristic | Sour | Yeast | | Pungent | | Firmness | | Elasticity | | Wall thickness | | Pores uniformity | |
| Yeast extract | Linear | | | 1 | 16.55\* | 78.33\* | 53.14\* | | 45.65\* | | 0.00 | | 1.79 | | 0.00 | | 0.84 | |
| Quadratic | | | 1 | 1.60 | 2.54 | 1.93\* | | 0.11 | | 1.94 | | 2.62 | | 0.20 | | 0.27 | |
| Salt | Linear | | | 1 | 0.44 | 1.19 | 2.44\* | | 1.84\* | | 0.04 | | 0.10 | | 0.36 | | 0.44 | |
| Quadratic | | | 1 | 0.02 | 0.38 | 0.04 | | 0.79 | | 0.05 | | 11.82\* | | 0.54 | | 1.79 | |
| Sugar | Linear | | | 1 | 6.67\* | 0.00 | 1.35\* | | 0.98 | | 24.75\* | | 9.08\* | | 19.08\* | | 30.06\* | |
| Quadratic | | | 1 | 0.26 | 0.49 | 0.02 | | 0.43 | | 0.29 | | 13.51\* | | 0.25 | | 3.43 | |
| Cross product | Yeast extract x salt | | | 1 | 2.70 | 0.02 | 0.02 | | 0.05 | | 6.06 | | 0.10 | | 5.01 | | 0.78 | |
| Yeast extract x sugar | | | 1 | 9.39\* | 0.00 | 0.05 | | 0.09 | | 16.53\* | | 10.01\* | | 14.16\* | | 5.92 | |
| Salt x sugar | | | 1 | 0.17 | 0.13 | 0.39\* | | 1.96\* | | 0.92 | | 0.70 | | 1.28 | | 0.24 | |
| Error | Residual variance | | | 4 | 2.56 | 2.83 | 0.14 | | 0.58 | | 7.56 | | 4.4 | | 5.32 | | 3.57 | |
| Total sum of squares | | | 13 | 59.59 | 92.97 | 68.75 | | 54.47 | | 63.29 | | 54.89 | | 52.95 | | 61.02 | |
| *R2* | | | | | 0.957 | 0.970 | 0.998 | | 0.989 | | 0.881 | | 0.920 | | 0.900 | | 0.942 | |

\* Statistically significant at level of significance of *p*<0.05

1df - degrees of freedom

Table S5. Regression coefficients of SOP of the bread with yeast extract model for chemical composition

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Protein  content | Starch  content | Fat  content | Total sugars  content | Cellulose content |
| *β0* | 19.48823\* | 60.25488\* | 0.561246\* | 0.112927 | 2.527256\* |
| *β1* | 0.66427 | -0.22688 | -0.006601 | 0.210073 | -0.037756 |
| *β11* | 0.09820 | 0.01303 | 0.000603 | 0.009180 | -0.002332 |
| *β2* | -2.75701 | 2.52659 | -0.038902 | 2.611951 | 0.255671 |
| *β22* | 0.60488 | -1.39415 | 0.008176 | -0.810488 | -0.128293 |
| *β3* | -0.38412 | -0.86644\* | -0.006511\* | 1.069037\* | -0.028628 |
| *β33* | 0.00505 | -0.00234 | 0.000087 | -0.008705 | -0.000283 |
| *β12* | -0.20322 | -0.34146\* | -0.001364 | -0.182878 | 0.019073 |
| *β13* | -0.01312 | -0.00095 | 0.000166 | -0.016288 | 0.000307 |
| *β23* | 0.09739 | 0.20727\* | 0.000438 | -0.015439 | 0.006537 |

\* Statistically significant at *p*<0.05 level

Table S6. Regression coefficients of SOP of the bread with yeast extract model for mineral composition

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Zn  content | Cu  content | Mg  content | Ca  content | Fe  content |
| *β0* | 21.05561\* | 5.905732\* | 238.2642\* | 95.7865\* | 43.74018\* |
| *β1* | 0.56339\* | -0.064232\* | 26.4998\* | 11.3420\* | 0.63632 |
| *β11* | 0.01643 | -0.001405 | -0.1098 | -0.4297 | -0.04075 |
| *β2* | 3.05707\* | 0.345488 | 80.8633 | -18.2048 | 1.78762 |
| *β22* | -1.22927\* | -0.185122\* | -28.3049 | 5.5468 | -0.84878 |
| *β3* | -0.19630\* | -0.082116\* | -4.1025 | -0.9203 | -0.66209\* |
| *β33* | 0.00191 | 0.002049\* | 0.0308 | -0.0045 | 0.01511 |
| *β12* | 0.04732 | 0.020780 | -2.4269 | -0.3957 | -0.10380 |
| *β13* | -0.00327 | 0.001078 | -0.2997 | -0.0220 | -0.01158 |
| *β23* | -0.02634 | 0.002390 | 0.4837 | 0.0511 | 0.06510 |

\* Statistically significant at *p*<0.05 level

Table S7. Regression coefficients of SOP of the bread with yeast extract model for instrumental colour and textrure characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *L\** | *a\** | *b\** | *C\** | Bread crumb quality |
| *β0* | 64.22543\* | 4.427622\* | 19.18201\* | 16.53756\* | -2.29909 |
| *β1* | 0.25357 | -0.382622 | 0.98349\* | 0.23244 | -0.05341 |
| *β11* | -0.03402 | 0.006966 | -0.00506 | -0.02772 | 0.03624 |
| *β2* | 0.05945 | 1.510915 | -2.90616 | 2.85171 | 5.68811 |
| *β22* | -0.09049 | -0.485854 | 1.38341 | -0.89293 | -1.84390 |
| *β3* | 0.30854 | 0.013939 | -0.05651 | 0.09072 | 0.65704\* |
| *β33* | -0.03660 | -0.000359 | 0.00003 | -0.01013 | -0.02344 |
| *β12* | 0.47912 | -0.006537 | -0.29585 | 0.14273 | 0.14098 |
| *β13* | -0.03149 | -0.001254 | 0.01321 | 0.01147 | -0.05590 |
| *β23* | 0.03056 | -0.008268 | 0.01307 | -0.01463 | -0.05451 |

\* Statistically significant at *p*<0.05 level

Table S8. Regression coefficients of SOP of the bread with yeast extract model for sensory characteristics

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | *β0* | *β1* | *β11* | *β2* | *β22* | *β3* | *β33* | *β12* | *β13* | *β23* |
| Appearance | Characteristic | 7.33780\* | 0.21220 | 0.00741 | -4.09146 | 1.78537 | 0.19110 | 0.00585 | 0.09366 | -0.00663 | -0.09317 |
| Crust colour intensity | -5.59817 | 0.29817 | -0.03951 | 11.27622 | -3.58780 | 0.36159 | 0.00112 | 0.60195 | -0.00980 | -0.10902 |
| Crumb colour intensity | 0.41220 | 1.13280 | -0.11941 | 3.94146 | -1.28537 | -0.11860 | 0.00415 | 0.18634 | -0.01537 | 0.13317 |
| Colour uniformity | 8.079878\* | 0.350122\* | -0.029366 | -0.138415 | 0.065854 | -0.077439 | 0.003659 | -0.161463 | -0.006146 | 0.029268 |
| Taste | Characteristic | 10.99573 | -2.59073\* | 0.11220 | -2.14451 | 0.10488 | -0.16787 | -0.01695 | 0.60878 | 0.10488\* | -0.06561 |
| Sweet | -4.98720 | 0.21720 | 0.26741\* | 8.63354\* | -2.91463\* | 0.09110 | -0.02215 | 0.03366 | -0.03463 | 0.12683 |
| Sour | -2.41707 | 0.52707 | 0.12878 | 5.02195 | -1.58049 | -0.00146 | -0.01780 | 0.01512 | 0.00151 | 0.10756 |
| Salty | 0.91159 | 0.44341 | 0.00976 | -1.05061 | 1.54390 | -0.16579 | 0.00144 | -0.24098 | 0.06390\* | 0.02951 |
| Aroma | Characteristic | 9.71037 | -2.72037\* | 0.12810 | -0.43476 | -0.39756 | -0.22268 | -0.01298 | 0.62439 | 0.11644\* | -0.07780 |
| Sour | -2.39024 | 0.32024 | 0.16127 | 4.97317 | -1.56829 | 0.07012 | -0.01768 | 0.05707 | 0.00171 | 0.06854 |
| Yeast | 0.548171 | 1.661829\* | -0.140488\* | 1.873780 | -0.512195 | -0.116585 | 0.003878 | 0.058049 | -0.008195 | 0.119024\* |
| Pungent | 7.71768\* | 1.17732\* | -0.03395 | -6.92988 | 2.25122 | -0.52384\* | 0.01651 | -0.08780 | 0.01122 | 0.26610\* |
| Texture | Firmness | 7.44207 | 1.34293 | -0.14078 | -0.44695 | 0.58049 | -1.14104 | 0.01380 | -0.93512 | 0.15449\* | 0.18244 |
| Elasticity | -15.6585\* | 1.4185 | -0.1636 | 25.3610\* | -8.6902\* | 1.1993\* | -0.0929\* | -0.1224 | -0.1202\* | 0.1588 |
| Wall thickness | 11.23415 | 0.78585 | -0.04556 | -4.94390 | 1.86098 | -1.10707 | 0.01261 | -0.85024 | 0.14298\* | 0.21488 |
| Pores uniformity | -4.51707 | -0.17793 | 0.05278 | 10.22195 | -3.38049 | 1.21604\* | -0.04680 | 0.33512 | -0.09249 | -0.09244 |

\* Statistically significant at *p*<0.05 level