

Cheese and bread produce a good combination of flavors. There are several cheese-flavored baked products in the market regardless of season. However, we rarely use natural cheese for these products because of three reasons: first, natural cheese is expensive. Second, the supply of natural cheese is unstable and mainly depends on import. Third, as the specific volume of bread containing natural cheese decreases, and quality of the bread also decreases. These reasons are considered as problems for cheese bread production. The demand for cheese bread is lower than low-sugar and gluten-free rice-flour bread. Therefore, there is not much reported information about the components and sensory properties of cheese bread. We studied the sensory characteristics, baking properties, and flavor components of cheese bread. The present study aims to develop a manufacturing method of high-quality cheese bread that will enhance both consumer approval and market value of cheese bread.

We evaluated 13 kinds of natural cheese, and dough was added with 13 kinds of cheese at an amount that was 10% of the mass of the wheat-flour. Both the  $L^*$  value of the crust and the specific volume of the bread decreased with the addition of cheese. The addition of cheese may have inhibited yeast fermentation in the dough, thereby decreasing the specific volume of gasification by inhibiting gluten formation. We then used a method to improve the quality of cheese bread by adjusting the fermentation and baking conditions. Then, we used an oxidizer and an enzyme to promote S–S binding and gluten formation.

We conducted a component analysis on the 13 kinds of natural cheese used in making cheese bread, and we determined the characteristic flavor components of cheese bread. Amino acid and fatty acid profiles contributed to the classification of cheese. In the 13 types of cheese, amino acids were determined to express the aging degree, whereas fatty acids expressed the degree of mold fermentation.

The flavor characteristics of several types of cheese bread were investigated through descriptive sensory evaluation. A panel of 10 judges that was selected and trained was commissioned to evaluate the 14 bread samples. A total of 52 sensory descriptive terms (44 smell terms and 8 taste terms) and 14 terms (9 smell terms and 5 taste terms) were developed from a roundtable discussion by the trained panel with previous experience in evaluating cheese bread. The bread that was added with cheese that has been aged for a long period was strong in umami taste, aftertaste, and baked cheese aroma. The bread that was added with cheese that was matured using mold was strong in an aroma that was similar to the smell of the mold. The bread that was added with cheese made from caprine milk had a strong, green, and moldy aroma, and an astringent taste. Principal component analysis (PCA) identified the first principal component as “rich flavor of cheese,” whereas the second component was identified as “baked flavor of cheese bread.”

The present study attempted to clarify the flavor components of pamigiano–reggiano cheese. We studied the 32 components of the model cheeses, including amino acids, fatty acids, and organic acids. We performed omission and addition tests to identify the flavor-active components of cheese bread. The flavor of the cheese bread was affected by sodium glutamate, valine, methionine, isoleucine, leucine, phenylalanine, proline, and butyric acid. PCA identified the first principal component as “rich flavor of cheese,” the second component as “baked flavor of bread,” and the third component as “fermented flavor”; and the overall flavor of the cheese bread comprised a balance of these flavor properties. We also analyzed the volatile components of the model cheese bread samples and the control bread. Aldehydes and alcohols were increased by adding valine, methionine, isoleucine, leucine, and phenylalanine; all of which may have been formed due to yeast fermentation and the Maillard reaction.

We performed sensory evaluation of the aroma of the cheese bread using color parameters. The aroma of bread was expressed as orange or yellow. PCA identified the first principal component as “brightness” and the second component as “hue.” The first component was interpreted as the strength or weakness of the aroma of baked cheese bread. The second component was interpreted as the balance of the aroma of the bread. Results showed that consumer acceptance may be increased by using this method in producing cheese bread, that the aroma produced by baking cheese bread was expressed as having a value of 4 for brightness. This suggests that we can clearly convey the aroma of cheese bread to consumers using color parameters.

Through this study, we were able to present a choice index in deciding what cheese to use in cheese bread production. This knowledge enables the production of high-quality cheese bread. Additionally, this method can be used to gain new insights into tapping other markets for cheese bread products, such as vegans (complete vegetarians), patients with lactose intolerance or allergy, including those with renal disease.