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FRESH ELDERBERRY OR SPINACH PURÉES AS DUAL NATURAL COLOUR AND EARLY TEXTURE MODULATORS IN SORGHUM GLUTEN-FREE BREAD

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KEYWORDS:
acceptability, clean-label, consumer test, principal component analysis, texture profile analysis

ABSTRACT
Gluten-free breads typically exhibit rapid firming and limited natural color diversity, which issues are usually addressed through multiple additives. This study evaluated the properties of adding fresh elderberry (*Sambucus nigra*) and spinach (*Spinacia oleracea*) purées (15–35 %, flour basis) as multifunctional ingredients for sorghum (*Sorghum oryzoidum*) gluten-free bread. Nine bread recipes were analysed for their instrumental texture, crumb CIELAB color, sensory profile, and consumer acceptability at 6 h and 24 h post-baking. At 6 h, bread with added spinach puree at 35 % achieved wheat-like softness, while bread with added elderberry pureeincreased crumb firmness. After 24 h, all breads firmed, but bread with added 35 % of spinacj puree remained substantially softer than the sorghum reference sample. Elderberry purée shifted crumb color towards red-violet hues, spinach puree did it towards green-yellow hues, while the variants of bread with added spinach showed the lowest 24 h color change ($\Delta E^*ab < 3.5$). Consumer scores were consistently high (⩾7.0 on day 1), with 35 % elderberry-enriched bread which retained the highest liking rating after 24 h. These findings demonstrate that fresh plant purées can expand natural colours diversity and attenuate early firming in gluten-free bread, supporting their application as clean-label alternatives to the conventional additives.

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ПЮРЕ ИЗ СВЕЖИХ ЯГОД БУЗИНЫ ИЛИ ПЮРЕ ИЗ ШПИНАТА КАК ДВОЙНОЙ НАТУРАЛЬНЫЙ КРАСИТЕЛЬ И МОДУЛЯТОРЫ КОНСИСТЕНЦИИ СОРГОВОГО БЕЗГЛЮТЕНОВОГО ХЛЕБА НА РАННИХ СРОКАХ ПОСЛЕ ВЫПЕЧКИ

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КЛЮЧЕВЫЕ СЛОВА:
приемлемость, природные ингредиенты, подпадающие под определение «чистая этикетка», потребительская оценка, анализ основных компонентов, анализ профиля консистенции

АННОТАЦИЯ
Безглютеновый хлеб обычно быстро черствеет и имеет ограниченное разнообразие природных цветов, что, как правило, исправляется многочисленными добавками. В этой статье оцениваются свойства пюре из свежих ягод бузины (*Sambucus nigra*) и шпината (*Spinacia oleracea*) (15–35 % от количества муки), примененных в качестве многофункциональных ингредиентов для безглютенового хлеба, выпеченного из сорго (*Sorghum oryzoidum*). Был проведен анализ девяти рецептур, где инструментально оценивалась консистенция, цвет мякиша по шкале цвета CIELAB, профиль органолептических свойств и уровень потребительской приемлемости через 6 и 24 часа после выпечки. Через 6 часов хлеб с добавлением шпината в количестве 35 % достиг уровня мягкости, сравнимого с пшеничным хлебом, в то время как добавленная бузина повысила черствость мякиша. Через 24 часа все виды хлеба зачерствели, но хлеб, испеченный с добавлением шпината в количестве 35 %, оставался значительно мягче, нежели контрольный образец, выпеченный из сорго. Пюре из ягод бузины изменило цвет хлебного мякиша в сторону красно-фиолетовых оттенков, пюре из шпината — в сторону зелено-желтого оттенка, при этом варианты рецепта с добавленным шпинатом показали наименьшее изменение цвета через 24 часа ($\Delta E^*ab < 3,5$). Потребительские оценки были неизменно высокими (⩾7,0 в первый день), при этом хлеб с добавлением 35 % бузины сохранил наивысшую оценку и через 24 часа. Эти результаты показывают, что применение пюре из свежих растительных материалов способно расширить естественное разнообразие цвета и уменьшить преждевременное черствение безглютенового хлеба, что подтверждает целесообразность их применения в качестве альтернативы традиционным добавкам, подпадающим под определение «чистая этикетка».

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