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Araştırma Makalesi / Research Article

Nutrition Design Modeling Method Development for Structural Analysis and Formulation Modeling of Giresun Hazelnut Using Field Emission Gun – Scanning Electron Microscope (FEG-SEM)

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Abstract

The structure analysis and composition modeling of Giresun hazelnuts were first time investigated to develop a nutrition design modeling method using the Field Emission Gun – Scanning Electron Microscope (FEG-SEM). Texture analysis of the hazelnut has shown cube-like oily surface, non- fibrous non-porous spreading structure, and particularly high elemental value of carbon (44.92%) and oxygen (45.562%), and P (1.22%), K (1.21%), Cl (7.09%) mineral elements stating that the Giresun hazelnut is oily spreading structure model, and natural oil carbohydrate and mineral models. The Giresun hazelnut was determined to be suitable for finely grinding to produce hazelnut flour and production of hazelnut nutrition assortments. The Giresun hazelnut was ground with water to produce white colored homogenized nonclotting vegetable type hazelnut milk with hazelnut aroma without additives.

Keywords: Nutrition design method development, structure analysis, composition modeling, Giresun hazelnut, Field Emission Gun – Scanning Electron Microscope (FEG-SEM).

Giresun Fındığının Alan Emisyon Tabancası–Taramalı Elektron Mikroskobu (AET-TEM) ile Yapısal İncelemesi ve Formülasyon Modellemesi için Besin Tasarım Yöntemi Geliştirilmesi

Öz

Giresun fındığının yapı analizi ve kompozisyon modellemesi, ilk kez Alan Emisyon Tabancası – Taramalı Elektron Mikroskobu (FEG-SEM) kullanılarak bir beslenme tasarımı modelleme yöntemi geliştirmek için incelenmiştir. Fındığın tekstür analizi sonucunda küp benzeri yağlı yüzey, lifsiz gözeneksiz sürülebilen yapısı ve özellikle yüksek karbon (44.92%) ve oksijen (45.562%) elemental değerleri, P (1.22%), K (1.21%), Cl (7.09%) mineral elementleri, Giresun fındığının yağlı sürülebilen yapı modeli olduğunu, ve doğal yağ karbonhidrat ve mineral modelleri gösterdiğini belirtmektedir. Giresun fındığının ince öğütülerek fındık unu üretimine ve fındık besin çeşitleri üretimine uygun olduğu belirlendi. Giresun fındığı su ile öğütülerek beyaz renkli homojenize pıhtılaşmayan bitkisel tür fındık aromalı ve katkısız fındık sütü elde edilmiştir.

Anahtar Kelimeler: Beslenme Tasarımı Yöntem Geliştirme, Yapı İncelemesi, Bileşen Modelleme, Giresun Fındığı, Alan Emisyon Tabancalı – Taramalı Elektron Mikroskobu (FEG-SEM).

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1. Introduction

Turkish hazelnuts are cultivated in the wide range of agriculture provinces located in Black Sea and Marmara regions where include Artvin, Rize, Trabzon, Giresun, Ordu, Samsun, Sinop, Düzce, Sakarya, Zonguldak and Kocaeli cities along with the suitable climate that 70% of the world's hazelnut cultivation products occur in these provinces (Islam, 2018).

The mineral element concentration ratios of hazelnut trees were investigated as indicators of nutrient deficiency and nutritional imbalance index was evaluated (Alkoshab et al., 1988). Determination of type and quality of shelled hazelnut varieties with image processing was studied, and it was reached 84% accuracy rate for grouping of shelled hazelnuts according to the type and commercial standards (Bayrakdar et al., 2015). The harvested hazelnuts were deshelled than mostly peeled and roasted for industrial or non-industrial use, and different methods were tried for peeling of the hazelnuts using the caustic solution treatments for peeled better quality hazelnuts (Kaleoğlu et al., 2004; Di Matteo et al., 2012).

Hazelnuts (*Corylus avellana L.*) contain adequate daily nutritional formulation as high value of carbohydrates, protein, vitamins and minerals, as well as the best naturally formulated nutrition sources. Wide range of accomplished experimental scientific research studies state the facts that hazelnut contains about 62% oil, 7% protein, 4% vitamin and 4% minerals holding good source of daily nutrition requirements (Açkurt et al., 1999; Özdemir et al., 20001; Alasalvar et al., 2003; Dundar and Altundag, 2004; Köksal et al., 2006; Simsek and Aykut, 2007; Alasalvar et al., 2009; Cosmulescu et al., 2013; Pelvan et al., 2018; Turan, 2018; Çetin et al., 2020; Karaosmanoğlu and Üstün, 2021; Calà et al., 2022; Sahin et al., 2022; Şeker, 2023). The oil carbohydrates of hazelnuts comprise oleic and linoleic acids, the amount of protein involves many of the vital amino acids including arginine, the vitamin composition includes comprising vitamin E, and the mineral content contains high levels of essential Fe, Mg, Cu, Mn, K, P, Zn and Ca minerals (Köksal et al., 2006).

Çetin et al. (2020) examined highest and lowest properties of hazelnut cultivars, and the oil and protein contents were specified as 63.25% and 13.63% respectively, and the oleic acid and linoleic acid levels, and Zn, Mn, and Cu minerals were quantified. Dundar and Altundag, (2004) analyzed the Se contents of different varieties of hazelnuts, and up to 1.6 mg/100 g Se was determined. In a recent elemental composition research, Şeker (2023) studied the elemental analysis and health risk assessment of different Giresun hazelnut varieties, and the elemental composition of hazelnuts was determined as in the following ranges (mg kg^{-1}); Mn: 58.9–193, Fe: 44.1–62.2, Zn: 27.0–53.8, Se: 0.01–0.12, Cr: < 0.0004–0.387, Cu: 16.9–25.8, Mg: 1132–1327, Ca: 1264–1899, K: 5459–6841, Na: 1.32–7.88, Pb: < 0.001, Cd: < 0.001, Ni: 0.82–2.52 and As: 0.003–0.009 (Şeker, 2023).

Özdemir and Devres (1999) related to the importance of processing and operation condition parameters for best quality hazelnut production, and it has been suggested that processing and microbial activities cause noteworthy lipid oxidation and quality loss due to imperfect harvest, drying, shelling, roasting and storage methods and conditions. The preeminence of Turkiye with 70% of hazelnut production, hazelnut market was examined using the comparative advantage power on international hazelnut market (Alkoshab et al., 1988).

High content of oil in hazelnut is extractable and processed to produce food grade natural vegetable hazelnut oil. Hazelnut can easily be ground to produce the commonly used hazelnut flour which is used for chocolate, confectionary and coffee mix nutrition assortment productions. Hazelnut is exceptionally soluble in water by liquid grinding which makes it possible to produce purely hazelnut originated hazelnut milk drink product. Patent application was issues to Turkish Patent Institute for hazelnut originated milk drinks production (Ermurat, 2010). The shell of the hazelnut is used for the bread production in bakery ovens due to the suitable caloric value of the hazelnut shell heat.

Numerous features of the marvels of the hazelnut can be revealed using the electron microscopy techniques for hazelnut nutrition design modeling method development in the hazelnut studies.

2. Materials and Methods

The whole oil unextracted peeled unroasted hazelnut samples obtained from the Giresun region were ground with hand grinder without using motor driven grinder. The FEI Quanta FEG 250 Field Emission Gun-Scanning Electron Microscopy (FEG-SEM) of Düzce University was used for microstructural and elemental investigations of the powdered hazelnut samples. Structural imaging and the 'Energy Dispersive X-Ray Analysis' (EDAX) elemental values data of the hazelnut samples were assessed. The Giresun hazelnut samples were ground and diluted to produce hazelnut milk without addition of additives. Creamy and spreading hazelnut product was prepared by addition of vegetable hazelnut oil and sugar to hazelnut flour and longtime mixing.

3. Results and Discussion

To build a nutrition design modeling approach, the peeled Giresun hazelnut samples were ground and first time evaluated using the advanced FEG-SEM to investigate the hazelnut structure and content. The structural imaging and the 'Energy Dispersive X-Ray Analysis' (EDAX) elemental values data elemental values data of the hazelnut samples were determined as shown in Figures 1-2,

and Tables 1-2. The structure analysis images of the hazelnut samples in the micro sizes of 200 μm (*a*) and 50 μm (*b* and *c*) were given in Figure 1 (a,b,c).

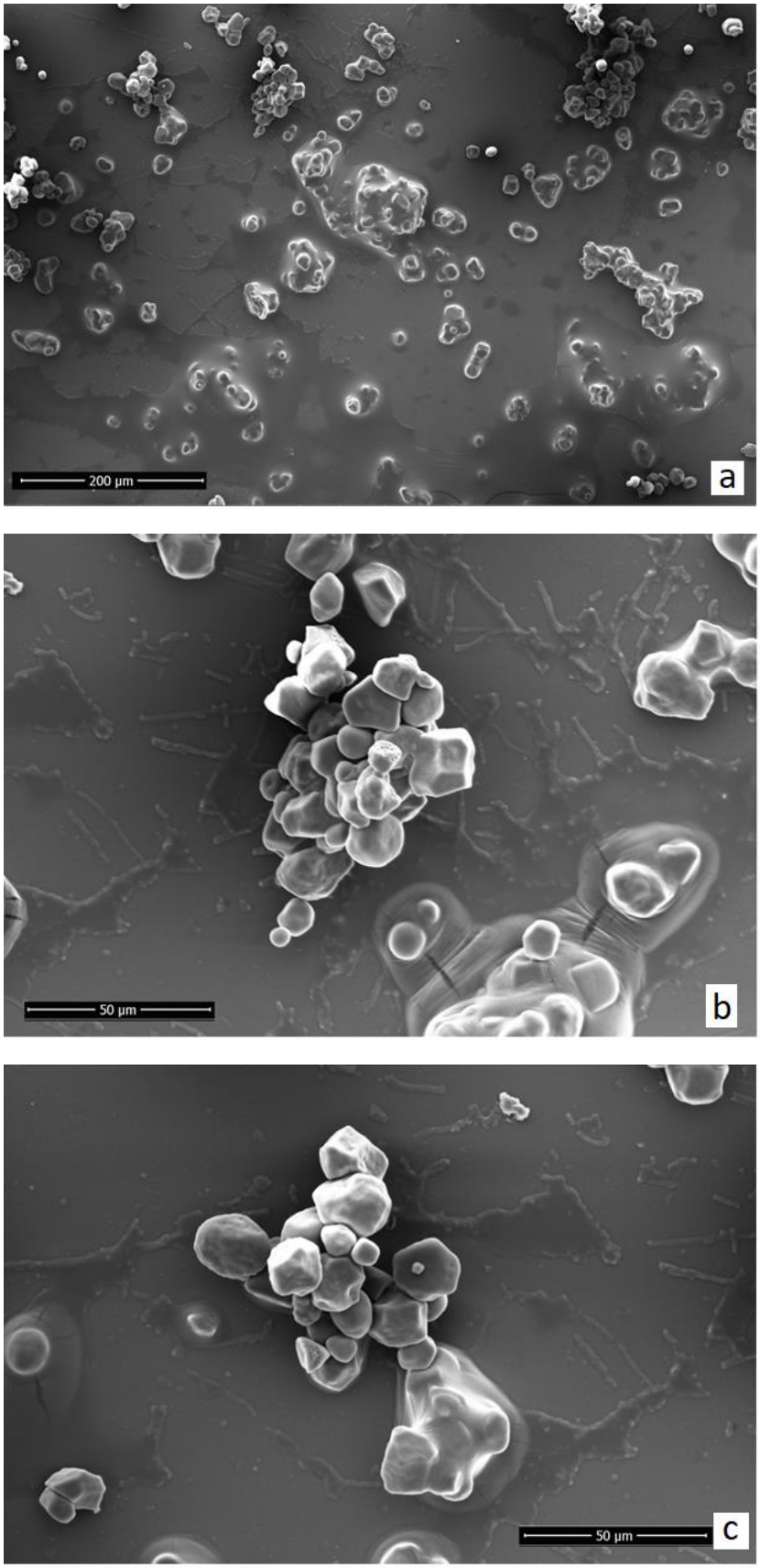

Figure 1 (a,b,c). The FEG-SEM images of powdered form of the Giresun hazelnut samples

Using the FEG-SEM technique for composition analysis, the peak patterns graph of the elemental constituents of the hazelnut samples was determined as shown in Figure 2.

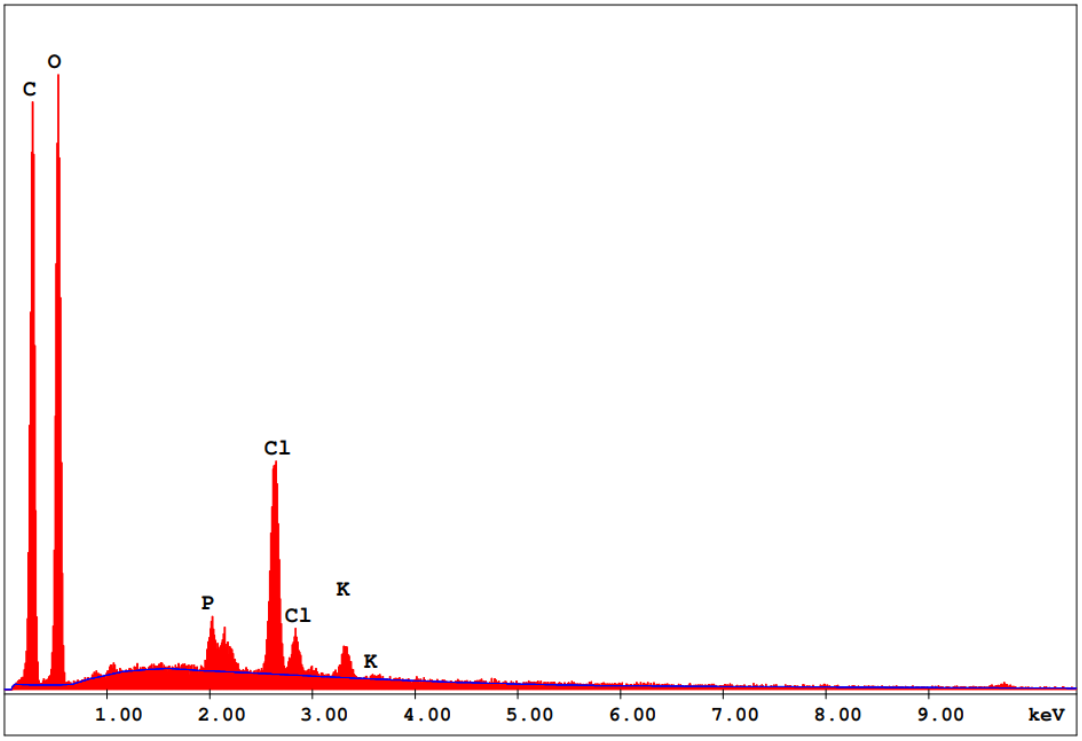

Figure 2. The FEG-SEM EDAX elemental values data of the Giresun hazelnut samples

Table 1 lists the original 'Energy Dispersive X-Ray Analysis' (EDAX) elemental constituent data of powdered form of the Giresun hazelnut samples.

Table 1. The elemental constituents of the Giresun hazelnut samples.

EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
C K	44.92	54.53	0.1275	1.0171	0.2789	1.0004
O K	45.56	41.53	0.0993	1.0002	0.2179	1.0000
P K	1.22	0.58	0.0102	0.9208	0.9033	1.0062
ClK	7.09	2.91	0.0628	0.8987	0.9846	1.0016
K K	1.21	0.45	0.0108	0.9069	0.9815	1.0000
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	309.04	2.69	1.08	114.83
O K	421.97	4.04	0.92	104.53
P K	48.59	22.42	3.74	2.17
ClK	260.56	23.30	1.27	11.18
K K	37.43	17.81	4.30	2.10

For systematic nutrition formulation of the hazelnut samples, the nutrition contents must be efficiently defined and formulated so that the amounts can be designed in accordance with the structure images and elemental analyses.

The hazelnut components are sensitive to chemical alteration by the chemical and microbial changes during the processing and storage, and application of the FEG-SEM technology can be used to determine the constituents of hazelnut, and enable possible progressive nutritional design method development in hazelnut production and utulisation. The appraised microstructural imaging and EDAX elemental values data of the Giresun hazelnut powder samples can be used for evaluation of the microstructural formation and elemental components formulation.

The electron microscopy analysis and the microstructure images of the peeled Giresun hazelnut have shown particularly cube like imperfect smooth oily surface, high value of carbon peaks with high carbon amount and minerals as shown in Figures 1-2, and Tables 1-2.

The texture image analysis of the hazelnut has shown findings in the form of the oil components which present oily creamy surfaces and uniform spreading structure, with no fibrous or porous configurations. The image analysis revealed discoveries that the appearance of the structure formation is described as cube-like non-fibrous non-porous oily surface, and uniform spreading structure model.

The evaluation of the hazelnut composition based on accomplished diagrams and preliminary analytical data indicates that the principally high value of carbon (44.92) and oxygen (45.562%), and P (1.22%), K (1.21%), Cl (7.09%) mineral elements specify natural oil carbohydrate nutrition content model, and P, K, Cl mineral model as noted in related hazelnut mineral studies (Açkurt et al., 1999; Alasalvar et al., 2003; Köksal et al., 2006; Simsek and Aykut, 2007; Cosmulescu et al., 2013; Karaosmanoğlu and Üstün, 2021; Calà et al., 2022; Şeker, 2023).

The content of oleic and linoleic oil acids that include carboxylic acids which were confirmed by high value of oxygen element in the hazelnut samples. The value of N representing protein and the essential amino acid content, and Fe, Mg, Cu, Mn, Zn, Ca and Se minerals were not detected by this electron microscopy application as reported in past studies (Köksal et al., 2006; Simsek and Aykut, 2007; Pelvan et al., 2018; Çetin et al., 2020; Karaosmanoğlu and Üstün, 2021; Sahin et al., 2022; Şeker, 2023).

The physical ability specifics of unroasted or roasted hazelnut samples allow easy grinding and production of hazelnut flour which is primarily used in chocolate, confectionary and coffee assortments and hazelnut milk making. Giresun hazelnut was finely ground to make powder form of hazelnut flour not even application of the motor driven grinding equipment. The Giresun hazelnut was ground with water to produce hazelnut milk with special homogenized smoothness and aroma which is instant liquefied hazelnut product can be consumed by all ages. Materially no clotting specifics were observed in the hazelnut milk under room temperature and atmospheric pressure

produced using the peeled unroasted or roasted Giresun hazelnuts. No additives were added to the milk, and no substances were used for the anti-coagulation. Microbial activities under microscope were not detected in heat treated and refrigerated hazelnut milk for 3 weeks, and 12 months in freezer. The dry particle contents of the hazelnut milk were fully separated using the centrifugal application. The produced creamy hazelnut product with spreading capability made by mixing of the hazelnut flour, hazelnut oil and sugar can be accounted as all day consumable high nutritive confectionary foodstuff.

4. Conclusions and Recommendations

The powder form of whole oil peeled unroasted Giresun hazelnut samples was first time examined using the FEG-SEM technology to have an advanced nutrition design modeling method development. The Giresun hazelnut samples possess no fibrous or porous surface and oily exterior peripheral due to the high oil content in the hazelnut composition. High carbon peak which refers to have high carbohydrate nutrition content due to the vegetable oil value, and oxygen amount supposed to be sourced from the oleic and linoleic acid substances. The texture analysis results indicate that the experimented hazelnut samples specify cube-like non-fibrous non-porous oily surface, and regular spreading structure characteristics model, and particularly high value of carbon peaks show natural oil carbohydrate and mineral model. The Giresun hazelnut is suitable for fine grinding with water to produce white colored homogenized non-clotting vegetable type hazelnut milk with special hazelnut aroma without addition of the additives. This hazelnut nutrition design modeling method reveals some characteristics of hazelnut perception and can be supportive to project production of Giresun hazelnut foodstuffs.

Statement of Research and Publication Ethics

The author declares that all the rules required to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" have been complied with in all processes of the article, that The Black Sea Journal of Science and the editorial board have no responsibility for any ethical violations that may be encountered, and that this study has not been evaluated in any academic publication environment other than The Black Sea Journal of Science.

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