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COMPARISON OF THE EFFECTS OF THREE DIFFERENT GRINDING PROCEDURES ON THE MICROSTRUCTURE OF "OLD-FASHIONED" NON-STABILIZED PEANUT BUTTER

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Abstract

Three different grinding procedures were utilized to prepare "old-fashioned" non-stabilized peanut butters. A leading commercial brand of stabilized peanut butter was used for comparison. The microstructure of each non-stabilized peanut butter was then evaluated with light microscopy and compared to the microstructure of the commercial brand of stabilized peanut butter. Major findings include: (1) dense spatial relationships of protein bodies, starch grains, and cell and tissue fragments that exist in "old-fashioned" non-stabilized peanut butter as compared to the well-dispersed spatial relationships which exist in commercially prepared stabilized peanut butter; and (2) degree of homogenization in the non-stabilized peanut butters was improved by coupling two grinding procedures sequentially.

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Introduction

Stabilized peanut butter is prepared by grinding shelled and roasted peanuts to which sugar, salt and stabilizing agents are added. Stabilizers, such as high-melting saturated fatty acid glycerides, function to prevent oil separation. Non-stabilized peanut butters contain no stabilizing agents and therefore may experience oil separation after the grinding process.

According to Woodroof (1983), grinding peanuts into butter is one of the simplest, yet one of the most delicate operations in the processing of peanut butter. Various devices used for grinding are referred to as comminutors, attrition mills, homogenizers, disintegrators, hammer mills or colloid mills. Peanut butter of very even texture is usually made by two grinding operations. The first reduces the peanuts to a medium grind and the second to a fine smooth texture.

The purpose of the present study is to compare the effects of three different grinding procedures on the microstructure of "old-fashioned" non-stabilized peanut butter. By utilizing a recently developed method of Young and Schadel (1990), the degree of homogenization (i.e., thoroughness of mixing of protein bodies, starch grains, oil and cell wall fragments of various sizes to achieve a complete dispersal) in three experimental non-stabilized peanut butters was compared with a leading commercial brand of stabilized peanut butter which has a high degree of homogenization of microstructural features. In the present study, the authors utilized light microscopy (LM) and not scanning electron microscopy (SEM) since oil obscures the microstructural features of peanut butter when examined with SEM.

Materials and Methods

Grinding Procedures for Non-Stabilized Peanut Butters

All three non-stabilized peanut butters were prepared using the same sample of U.S. Commercial Grade Virginia #1 blanched, roasted peanuts. After preparation, the peanut butters were placed in separate jars.

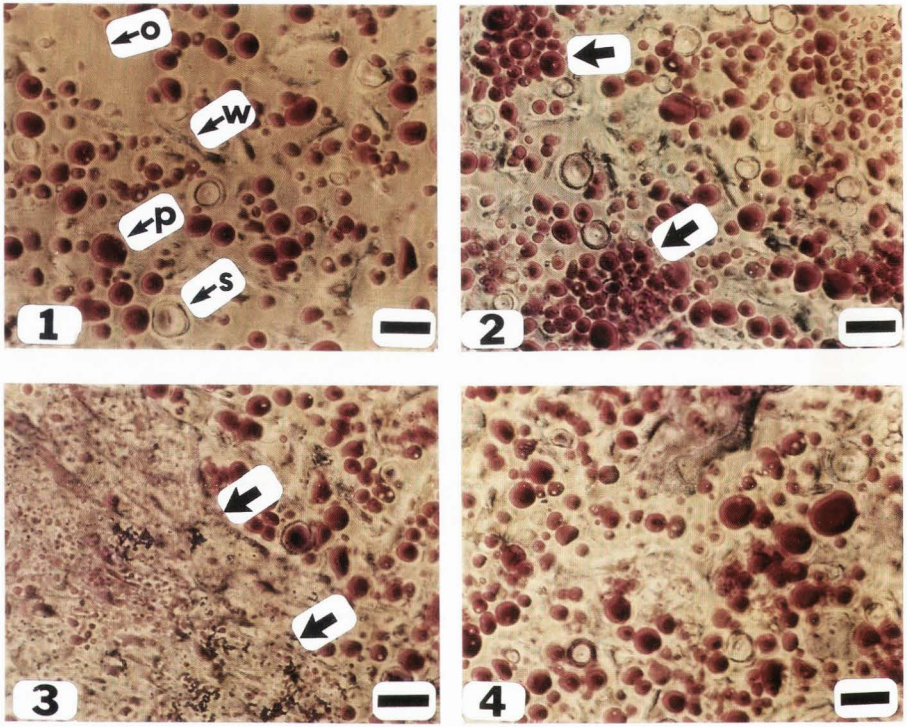

Fig. 1. Light micrograph of commercially available stabilized peanut butter in which broken cell wall fragments (w), protein bodies (p), and starch grains (s) are well-dispersed in a matrix of stabilized oil (o).

Fig. 2. Light micrograph of non-stabilized peanut butter #1 in which the microstructural features were not uniformly distributed. Note clumps of protein bodies (arrows).

Fig. 3. Light micrograph of non-stabilized peanut butter #1 in which comparatively large cell and tissue fragments (arrows) were observed.

Fig. 4. Light micrograph of non-stabilized peanut butter #3. Note the spatial relationship of protein bodies, starch grains and cell fragments which is comparable to the well-dispersed spatial relationship of the microstructural features of the commercial brand of stabilized peanut butter in Fig. 1.

Bar = 10 micrometers (on each figure).

Peanut butter #1 was prepared by grinding the roasted peanuts using an Old Tyme peanut butter mill. The product was passed through this mill two additional times to achieve greater uniformity.

Peanut butter #2 was prepared by The Koeze Company of Wyoming, Michigan by initially using a Bauer mill for the primary grind and then using an Urschel mill with a 200 mesh screen for the secondary grind.

Peanut butter #3 was prepared by grinding peanut butter #2 further using a Tekmar Tissumizer SDT-1810 motor with a 182EN shaft and generator operated at full speed.

Source of Stabilized Peanut Butter

One jar of a leading commercial brand of stabilized peanut butter was purchased at a local grocery store for the purpose of comparison.

Preparation of Samples for Light Microscopy

Ten peanut butter samples (1 mm^3) were randomly cut with razor blades from the top of each of the four jars (three non-stabilized and one stabilized). These samples were fixed using Karnovsky's fixative (1965) as modified by Young and Schadel (1990). Fixed and dehydrated peanut butter samples were embedded in resin using the methodology of Spurr (1969) for long pot-life resin. Sections, 3μm in thickness, were cut using a Reichert ultramicrotome and glass knives. After mounting sections on glass slides, the sections were stained with acid fuchsin and toluidine blue using the methods of Feder and O'Brien (1968). Stained sections were photographed using a Wild light microscope fitted with a 35 mm camera.

Results

Observation with LM revealed differences in degree of homogenization resulting from the three different grinding procedures among the non-stabilized peanut butters. The non-stabilized peanut butters were compared with a leading commercial brand of stabilized peanut butter.

The commercial brand possessed a high degree of homogenization in which broken cell wall fragments, protein bodies and starch grains were consistently well-dispersed in a stabilized oil matrix (Fig. 1). Non-stabilized peanut butter #1 possessed a variable degree of homogenization which ranged from intermediate in which clumps of protein bodies were observed (Fig. 2) to low in which comparatively large cell and tissue fragments were observed (Fig. 3). Non-stabilized peanut butter #2 was similar to peanut butter #1. Only non-stabilized peanut butter #3 possessed a consistently high degree of homogenization of microstructural features (Fig. 4) among the non-stabilized peanut butters.

Discussion

The microstructure of all three non-stabilized peanut butters exhibited a slightly more dense spatial relationship of protein bodies, starch grains, and cell and tissue fragments as compared to the well-dispersed spatial relationship of the microstructural features of the commercial brand of stabilized peanut butter. We believe that the reasons for this are two-fold: (1) added stabilizer in the commercial brand prevented oil separation which occurred to some extent in the non-stabilized peanut butters; and (2) proper mixing in the commercial brand insured complete and uniform dispersion of the microstructural features as the peanut butter stabilized.

The grinding procedure used to prepare non-stabilized peanut butter #1 demonstrated that two additional passes through an Old Tyme peanut butter mill did not insure a high degree of homogenization as comparatively large cell and tissue fragments were observed in the final product.

The grinding procedure used to prepare non-stabilized peanut butter #2 demonstrated that a primary grind through a Bauer mill and then a secondary grind through a Urschel mill with a 200 mesh screen likewise did not insure a high degree of homogenization. Comparatively large cell and tissue fragments were observed in the final product.

The method of grinding for non-stabilized peanut butter #3 using a Tekmar Tissumizer coupled to the grinding procedure used to prepare non-stabilized peanut butter #2 demonstrated that a high degree of homogenization of microstructural features can be accomplished in an "old-fashioned" non-stabilized peanut butter by coupling grinding procedures sequentially. This high degree of homogenization was best achieved by an initial grinding procedure which employed both a primary and secondary grind which was then coupled sequentially to an additional grinding procedure.

Acknowledgements

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Discussion with Reviewers

O. Flint: Would cryostat sections of fixed peanut butter samples yield the same information as resin embedded sections of fixed peanut butter samples?
Authors: Our experience with cryostat sectioning is that a frozen sample of peanut butter is not hard enough to section without inducing additional mixing of protein bodies, starch grains, cell wall fragments and oil by the blade during cryostat sectioning. Resin embedment was determined to be the more suitable method for evaluating degree of homogenization induced by grinding procedures alone because spatial relationships of components within a resin embedded peanut butter sample do not change during sectioning.

I. Heertje: Since oil on the surface of peanut butter obscures the microstructural features when examined with SEM, would it not be a better technique to fracture through the specimens and observe by cryo-SEM?
Authors: Although the use of cryo-SEM to examine fractured specimens would circumvent the problem of oil on the surface of peanut butter obscuring the microstructural features, the use of cryo-SEM would not solve the problem of SEM's lack of capability to differentiate spherical protein bodies from spherical starch grains in fractured specimens. Light microscopy of resin embedded peanut butter sections, in which protein is stained red with acid fuchsin, provides a means of distinguishing red protein bodies from white starch grains.

I. Heertje: What is the nature and the function of the stabilizer? Is it a surfactant which stabilizes an oil/water matrix and in this manner prevents oil exudation? What is the function of the native protein in this respect?
Authors: Peanut butter stabilizers are not surfactants. Furthermore, the native protein in peanut butter performs no function in stabilizing peanut butter. Peanut butter stabilizers are for the most part high-melting saturated fatty acid glycerides. The glycerides may be mono-, di-, or triglycerides, and triglycerides must be derived from hydrogenated vegetable oils or peanut oil. An ideal peanut butter stabilizer would best function by having relatively low solids content at 10°C and retaining a good proportion of that solids content at 37°C. When used in peanut butters, it will produce non-waxy mouth-feel characteristics, be spreadable at low temperatures and prevent oil separation.

I. Heertje: It is mentioned that peanut butter #3 has the most homogeneous structure of the non-stabilized products. Did it also show the least oil exudation? If so, what are the implications for the function of the stabilizer?
Authors: Oil exudation in non-stabilized peanut butter is dependent on storage time and storage temperature. Although oil exudation was not evaluated in the present study, oil exudation will eventually occur in a non-stabilized peanut butter that has a homogeneous structure.

D.N. Holcomb: Was there some reason for using razor blades rather than spatulas to remove peanut butter samples from the jars?
Authors: Razor blades are necessary because small sample blocks ($\sim$ 1 mm^3) must be cut from the jars of peanut butter. Spatulas which have no cutting edges are therefore inappropriate sampling instruments for peanut butter microtechnique.

M.G. Smart: Can you provide some quantitative data on the structures observed?
Authors: Quantitative measurements have not yet been made. We are planning to perform quantitative analysis in the near future and will report on it at that time. For the purpose of the present paper the differences are great enough and qualitative microscopy is adequate.