Sensory and Nutritional Properties in One Variety of Norwegian Whole Grain Bread

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ABSTRACT

Kneipp bread from 24 bakeries in eastern and western Norway was analyzed for iron, thiamine, dietary fiber, and sensory properties. The amount of whole grain flour in each sample was calculated on the basis of its dietary fiber content. A considerable variation was found in iron and dietary fiber content and consequently also in whole grain flour content. Results also indicated that whole grain flour content in Kneipp bread has increased over the past five years. Sensory properties were correlated to content of dietary fiber. Significant correlation was found between fiber and impression of crust and crumb, texture of crust, and flavor.

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It is part of Norwegian nutrition policy to increase grain consumption, especially through products containing whole grain flour. One way to achieve this is by increasing consumption of whole grain bread. It is therefore important that the market offer a variety of breads that suit consumer preferences.

A consumer study (Rognerud et al 1982) shows that consumers consider nutritional value an important factor in bread and associate high nutritional value with a high content of whole grain flour; such bread is also often preferred because of its taste. Thus it is important to consumers that a good selection of dark bread is available and that they are given the necessary information about the product as background for their choice when buying bread.

The whole grain content is important information for the consumer, but only a few bread products include such information on the label. The most widely used variety of bread in Norway containing whole grain flour is Kneipp bread. A previous survey showed that the content of whole grain flour in the recipes varies among bakeries (Rognerud and Riise 1983). The objective of this study was to determine the actual content of some nutrients and the whole grain flour content in Kneipp bread from different bakeries.

With increasing extraction rate, the content of both dietary fiber and ash (minerals) will increase. Dietary fiber is suitable as a measure for the extraction rate. Ash content, however, is not a good measure of whole grain flour in cereal products, because these products usually have added salt, and white flour can also be enriched with minerals. In either case the ash content will not reflect the extraction rate of the flour.

Sensory properties of bread are related to consumer acceptability. If the goal of increased bread consumption, particularly of dark bread, is to be achieved, it is necessary that these varieties have satisfactory sensory properties. Norwegian consumers claim they prefer dark bread for its taste (Rognerud et al 1982). An increase of whole grain flour in bread should preferably increase consumer acceptability of the products. Therefore, it was also an objective of this study to investigate possible correlations between whole grain flour content and different sensory properties.

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MATERIALS AND METHODS

Kneipp bread was collected from 12 large industrial bakeries and 12 small bakeries. Twelve bakeries were located in eastern Norway, and 12 were in the western part of the country. Ten loaves, which weighed approximately 800 g each, were collected from each bakery on three different days, to allow for daily variation in the production. The total number of samples was thus 72. The samples were collected from the bakeries within 1 hr after baking, wrapped in paper bags, and shipped to the National Institute for Consumer Research. Samples from the western areas were shipped by air in closed cardboard boxes. Samples from the Eastern areas were transported by car in open boxes, which allowed the steam to escape. All samples arrived at the Institute within 5–6 hr after baking, and the sensory evaluation was carried out immediately.

Sample Preparation for Chemical Analysis

Each bakery sample for chemical analysis consisted of three loaves. Each loaf was divided into halves. One half was stored in a deep freezer as a reserve; the other was sliced in approximately 1-cm thick slices, and every third slice of the three half loaves was combined to form one analytical sample of approximately 400 g. The samples were weighed, dried on a tray at room temperature for 3–5 days, reweighed, crushed in a Kenwood blender, and ground in a Tecator Cyclotec mill with a 1-mm sieve. The samples were stored in closed jars at room temperature.

Moisture

Moisture was determined by a method described by the Nordic Committee for Food Analyses (1953). Samples (2 g) of the air-dried material were dried at 130° C for 2 hr. Moisture content was calculated as the sum of weight loss by air drying and drying at 130° C.

Iron

Dry ashing was done on an aliquot of the air-dried material at 450° C for 18 hr. Deionized water was added, and the sample was

heated at 450° C for another 2 hr to remove traces of carbon material; 5 ml of 6*N* HCl was added and evaporated on a hot plate. The ash was dissolved in 0.1*N* HNO_3 diluted to an appropriate concentration for measurement. Measurements were carried out on a Perkin-Elmer model 2380 atomic absorption spectrophotometer, at the conditions recommended by Perkin-Elmer (1976).

Thiamine

Thiamine was analyzed according to an AOAC method (1970) with the minor adjustments recommended by the ICC (1972). The sample was hydrolyzed by 0.1*N* HCl and α-amylase (Taka-diastase; Fluka AG, Switzerland). Thiamine was purified on a base-exchange silicate column (Thiochrome Decalso, Fisher Scientific Co. no. T-97), oxidized to thiochrome by means of $K_3Fe(CN)_6$ in alkaline solution, and the fluorescence of the thiochrome was measured in a Perkin-Elmer fluorescence model 203 spectrophotometer.

Dietary Fiber

Dietary fiber content was determined using Hellendoorn's gravimetric, enzymatic method (1975), described by Asp et al (1983). To remove starch completely, an extremely heat-stable enzyme, amylase (Termamyl 60L, Novo, Copenhagen, Denmark), was used in an initial gelatinization step at 100° C for 15 min.

Further enzyme digestions were performed with pepsin (Merch no. 7190) at pH 1.5 and with pancreatin (Sign no. P-1750) at pH 6.8, both for 1 hr at 40° C. Soluble dietary fiber components were precipitated with ethanol, recovered together with the insoluble fiber components by filtration in a Tecator Fibertec system (Tecator AB, Höganäs, Sweden). Dietary fiber values given are corrected for residual protein (Kjeldahl method) and ash. The dietary fiber values reported in Table I are means of duplicate gravimetric analyses. The values are given on a moisture-free as well as wet weight basis.

Determination of the Whole Grain Flour Content

A linear correlation has been shown between dietary fiber and whole grain flour in bread. However, dietary fiber content seems to be higher in bread than in the corresponding flours (Siljeström et al 1982). This is probably a result of the resistant starch formed during baking (Johansson et al 1984). It is important, therefore, to use a standard curve based on baked bread when correlating dietary fiber content to whole grain flour content. When using a standard curve based on flour, the formation of resistant starch and other fiber-like constituents must be considered. In this study we estimated the whole grain flour content in the bread from a standard curve based on baked bread (Siljeström et al 1982). In this curve, the dietary fiber content of baked bread was plotted against the whole grain flour content. The whole grain flour content in the Kneipp bread samples was obtained from the standard curve by using the dietary fiber content of the bread corrected for undigestible protein and ash.

TABLE I
Dietary Fiber and Whole Grain Flour Contents of Kneipp Bread from Different Bakeries in Norway

Bakery No.	Bakery Size	Dietary Fiber Wet Weight (%)	Dietary Fiber Dry Matter (%)	Content of Whole Grain Flour (%)
Eastern Norway				
1	Small	6.0	9.3	65
2		4.7	7.3	40
3		4.8	7.4	40
4		5.1	7.8	45
5		4.0	6.3	25
6		4.8	7.6	45
7	Large	4.7	7.5	45
8		5.8	9.2	65
9		4.9	7.8	45
10		5.2	8.1	50
11		4.8	7.3	40
12		4.8	7.4	40
Western Norway				
13	Small	3.6	5.6	20
14		5.8	8.7	55
15		4.5	7.2	40
16		4.8	7.6	45
17		4.9	7.7	45
18		5.3	8.1	50
19	Large	4.6	7.1	35
20		3.9	6.2	25
21		5.3	8.2	50
22		5.5	8.5	55
23		4.6	7.0	35
24		3.7	5.6	20
Mean		4.9	7.5	45

Sensory Methods

The sensory analyses were carried out by a laboratory panel of 10 judges. The panelists were selected through interviews and discrimination tests, i.e., threshold tests. Before starting this project, they underwent training to evaluate different sensory properties in bread.

The method used scored seven different characteristics on a seven-point scale. The properties evaluated were evenness of the surface of bread slices, texture of crust (from "crisp" to "doughy"), two texture characteristics of the crumb ("firm" to "crumbly" and "dry" to "doughy"), bread flavor, saltiness, and sweetness. Total impression of crust and crumb was also evaluated on an affective scale.

The sensory analyses were made on the same day as the loaves were baked. Each bakery sample for sensory analysis consisted of seven loaves, each divided into equal halves. The panelists were given a half loaf of Kneipp bread each and cut their own slices for evaluation. Four samples were given per session.

Statistical Methods

One-way analysis of variance of sensory data and dietary fiber content was made using the Bonferroni test, and correlation coefficients were calculated using the Pearsons test (SAS Institute 1982).

RESULTS AND DISCUSSION

Content of Dietary Fiber

From a nutritional point of view, the whole grain content of bread should be increased, which would lead to an increase of dietary fiber content in the diet. It is therefore important to give consumers information on whole grain content. Dietary fiber content in all samples is shown in Table I. On a moisture-free basis, dietary fiber content of bread from 24 bakeries ranged from 5.3 to 9.3%, showing considerable variation. This indicates a difference in fiber-rich ingredients in the various recipes, even though the bread was supposed to be of the same variety. As indicated, three different loaves of bread were analyzed from each bakery. There were no significant differences in dietary fiber content within the samples, indicating that each bakery reproduced its recipes well.

Table II shows the mean fiber content of bread from small and large bakeries and from the two geographical regions. There was no significant statistical difference in fiber content between bread from the two types of bakeries or from the different geographical regions, although bread from the western area had a lower mean value.

Whole grain flour content in bread samples from different bakeries is shown in Table I. The data show a large variation in whole grain flour content, which ranged from 20 to 65%, indicating considerable differences between bakeries. This agrees with data found in a survey (Rognerud and Riise 1983) where Kneipp bread recipes were collected from a large number of bakeries, and the proportion of whole grain flour was calculated. In this study, content varied between 20 and 70%. In the earlier study, 30% was most frequently used, whereas 45% was the most common in the present study. The two results cannot be directly compared because they were achieved by two different methods; however, such data do indicate that whole grain flour content of Kneipp bread has

TABLE II
Means of Selected Nutrients in Kneipp Bread from Different Bakeries in Norway

	Number of Bakeries	Per 100 g of Bread			
		Moisture (g)	Dietary fiber (g)	Iron (mg)	Thiamine (mg)
All bakeries	24	35.5 ± 1.3	4.9 ± 0.7	1.8 ± 0.4	0.13 ± 0.02
Eastern Norway	12	35.7 ± 1.4	5.0 ± 0.7	1.8 ± 0.3	0.13 ± 0.01
Western Norway	12	35.4 ± 1.2	4.7 ± 0.8	1.9 ± 0.5	0.13 ± 0.02
Small bakeries	12	35.4 ± 1.1	4.9 ± 0.7	1.9 ± 0.2	0.13 ± 0.02
Large bakeries	12	35.7 ± 1.0	4.8 ± 0.6	1.8 ± 0.2	0.13 ± 0.02

TABLE III
Sensory Properties of Kneipp Bread from 24 Different Bakeries in Norway

Sensory Property	Scores (Scale 7-1)	
Total impression of crust	5.15 ± 0.51	very good/very poor
Total impression of crumb	5.11 ± 0.48	very good/very poor
Evenness of slice surface	4.85 ± 0.64	very even/very uneven
Texture of crust	4.36 ± 1.05	very crisp/very soft
Texture of crumb		
firm/crumbly	4.07 ± 0.69	very firm/very crumbly
dry/doughy	3.74 ± 0.49	very dry/very doughy
Flavor	4.51 ± 0.59	very distinct/none
Saltiness	2.82 ± 0.71	very distinct/none
Sweetness	2.15 ± 0.40	very distinct/none

increased, in accordance with the nutritional goal of increased whole grain consumption.

Because there is no enrichment of flour in Norway, the content of other nutrients in bread, such as iron and thiamine, also increases with the whole grain flour content. Thiamine and iron content of the bread samples is outlined in Table II. The standard deviation was fairly large for iron but smaller for thiamine, reflecting a spread in the content of the nutrient in the different samples. No difference was observed in iron or thiamine content as a function of geographical region or size of bakery.

Sensory Properties Correlated to Dietary Fiber

Nine different sensory properties that have been shown to be important in characterizing Kneipp bread (Wilsher 1981) were evaluated on a seven-point scale. Mean values and standard deviations are shown in Table III. The overall evaluation of both crust and crumb was "good," and the cutting surface was "even." The mean value for crumb texture was between "slightly crisp" and "slightly soft." The properties describing texture were "firm" to "crumbly" and "dry" to "doughy." Results showed that the mean value was close to the middle of the scale for both properties. The flavor was characterized as "distinct bread flavor." The results indicated that scores both for saltiness and sweetness were low.

We expected that the sensory properties of bread would be related to the content of whole grain flour. The results for the different sensory properties were therefore correlated to the content of dietary fiber (Table IV). A significant and positive

TABLE IV
Correlation Between Content of Dietary Fiber and Sensory Properties of Kneipp Bread

Sensory Property	Correlation Coefficient[1]
Total impression of crust	0.280*
Total impression of crumb	0.313**
Evenness of slice surface	n.s.
Texture of crust	0.280*
Texture of crumb	
firm/crumbly	n.s.
dry/doughy	n.s.
Flavor	0.352**
Saltiness	0.409***
Sweetness	−0.251*

[1]n.s. = Correlation not significant. * = $P<0.05$, ** = $P<0.01$, and *** = $P<0.001$.

relationship was found between fiber content and total impression of crust and crumb, texture of crust, and flavor ($P<0.05$). However, the correlation coefficients are low, all being 0.4 or less, and we cannot postulate a clear increase in sensory scores with increasing whole grain flour content. On the other hand, a decrease in sensory score is unlikely. It is thus unlikely that an increase in whole grain flour content will lead to reduced sensory quality of the bread.

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