# Effect of Cooking Methods on Dietary Fibre Components of Fresh Vegetables, Legume and Cereal Samples

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**ABSTRACT:** Neutral detergent fibre (NDF), acid detergent fibre (ADF) and hemicellulose contents of 8 fresh vegetables and 6 legumes and cereals were studied by microwave, pressure and conventional cooking methods. The raw vegetables contained 10.8-34.2% NDF, 9.2-28.2% ADF and 1.2-6% hemicellulose, respectively. NDF contents of vegetables for conventional, pressure and microwave cooking were ranged 8.8-29.6, 8.1-26.5, 9.1-28%. ADF and hemicellulose contents of vegetables for conventional, pressure and microwave cooking were ranged 8.6-25, 8.1-23, 8.9-23.7% and 0.9-4.6, 0.6-3.5, 0.6-4.3%, respectively. NDF, ADF and hemicellulose contents for raw legumes and cereals were ranged between 9.2-30.1%, 7.3-21.5 %, and 1.9-20.6%, respectively. The values for conventional, pressure and microwave cooking of NDF, ADF and hemicellulose contents for legumes and cereals were ranged between 7.4-23.1%, 6.1-21.6%, 7.1-23.3%, 6.1-20%, 5.2-20%, 5.9-20.5%, and 1.3-16.2%, 0.9-14%, 1.2-16.2%, respectively. Pressure-cooking showed a more pronounced effect on the reduction of these dietary fibre components than conventional and microwave cooking.
**Keywords:** ADF, NDF, hemicellulose, fresh vegetable, legume, cereal.

## Pişirme Tekniklerinin Taze Sebze, Baklagil ve Tahıl Örneklerindeki Diyet Lif İçeriğine Etkisi

**ÖZET:** Sekiz farklı taze sebze, 6 baklagil ve tahıl örneklerindeki nötral deterjan lif (NDF), asit deterjan lif (ADF) ve hemiselüloz içerikleri normal, basınçlı kapta ve mikrodalgada pişirme tekniği uygulanarak incelenmiştir. Çiğ sebzelerin içerdiği NDF % 10.8-34.2, ADF % 9.2-28.2, hemiselüloz % 1.2-6 olarak tespit edilmiştir. Sebzeler, normal, basınçlı kapta ve mikrodalgada pişirildiğinde NDF % 8.8-29.6, 8.1-26.5, 9.1-28, ADF % 8.6-25, 8.1-23, 8.9-23.7 ve hemiselüloz % 0.9-4.6, 0.6-3.5, 0.6-4.3 arasında tespit edilmiştir. Çiğ baklagil ve hububat örneklerinin NDF, ADF ve hemiselüloz içerikleri % 9.2-30.1, 7.3-21.5 ve 1.9-20'dir. Örnekler normal, basınçlı kapta ve mikrodalgada pişirildiğinde NDF % 7.4-23.1, 6.1-21.6, 7.1-23.3, ADF % 6.1-20, 5.2-20, 5.9-20.5 ve hemiselüloz 1.3-16.2, 0.9-14, 1.2-16.2 arasında gözlenmiştir. Basınçlı kapta pişirme diğer pişirme tekniklerine göre örneklerin NDF, ADF ve hemiselüloz içeriklerinde daha fazla düşüşe neden olmuştur.
**Anahtar Kelimeler:** ADF, NDF, hemiselüloz, taze sebze, baklagil, tahıl.

## INTRODUCTION

Legumes and vegetables occupy an important place in human nutrition. They are rich in proteins and complex carbohydrates (dietary fiber) and are an important source of minerals and vitamins (Rege, 1981). High dietary fiber content foods are recommended in the diets of health vulnerable (e.g. diabetes) populations (Sukminder et al., 1982). Furthermore, dietary fibre plays an important role in reduction of cholesterol levels in some hiperlipidemic individuals (Anderson et al., 1999; Kushi et al., 1999) and, in diabetes, it can also be used to improve glucose tolerance (Chandalia et al., 2000; Jenkins et al., 2003). Dietary fibre also seems to have a positive effect on diarrhea and constipation and as a treatment for irritable bowel (Bosaeus, 2004). It has anti-inflammatory and anti-carcinogenic effects on the digestive system (Scheppach et al., 2004). Low dietary fibre intake has been associated with a variety of diseases such as diverticular disease, constipation, appendicitis, diabetes, obesity, coronary heart disease and bowl cancer (Spiller and Amen, 1975).

Legumes are second to cereals as important sources of dietary fiber (DF), protein and starch. Grain legumes are major sources of resistant starch (RS) and DF, which could explain part of their metabolic effects. RS is defined as dietary starch, which is not digested in the small intestine, but later is fermented by natural microflora of the colon to produce short chain fatty acids (Berry, 1986), an action akin to that exhibited by DF.

Gravimetric methods for the analysis of dietary fiber can be divided into two groups. The first (detergent acid and neutral methods, ADF and NDF) consists in the gravimetric determination of residue previously treated with acid and neutral detergent solutions. These methods determine the insoluble fraction and their individual components (Van Soest´s methods). The second group uses amylolytic and/or proteolytic enzymes determination insoluble and soluble fraction. Dietary fibre is determined gravimetrically as total dietary fibre (TDF) after hydrolytic degradation of foods. TDF consists of soluble dietary fibre (SDF) and insoluble dietary fibre (IDF) and its importance in nutrition has been widely studied (Prosky and DeVries, 1991; Robertfroid, 1993).

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Asp et al. (1983), reported that, in addition to the soluble and insoluble fractions, partly-soluble fractions also exist. According to Mongeau and Brassard (1995), the method for TDF determination of Prosky et al. (1988) gives high values.They suggest that the IDF value may contain, also some starch which can be resistant (resistant starch-RS) and/or residual. Residual starch can be used by the human organism as a source of energy, while resistant starch is non-digestible.

Most of the vegetables and legumes are cooked by a simple boiling process before use. They are prepared traditionally for consumption in several ways as conventional and pressure cooking and microwave ovens are also being used. A number of changes may be in physical characteristics, chemical composition and dietary fibre components of vegetables and other food materials by cooking processes (Spiller, 1986; Sukhwant et al., 1992; Rehman et al., 2003). In the literature regarding the dietary fibre components in raw and cooked vegetables, legumes and cereals, very little information is available. The present study was undertaken to investigate the effects of different cooking methods on insoluble dietary fibre components of various fresh vegetables, legumes and cereals.

## MATERIALS and METHODS

### Materials

Fresh vegetables (cabbage, leek, carrot, potatoes, french bean, green pea, broad bean, spinach) and legumes and cereals as kidney bean, lentil, bean, chickpea, maize and rice were purchased from established commercial sources in 2006 to study the effects of three different cooking methods on dietary fibre components.

Non-edible parts were removed and edible parts of the samples were washed and cut into pieces and then cooked by three different methods in triplicate, as given below. Fresh vegetable samples were cooked for 10 min in all of the cooking procedures, legumes and cereals were cooked for different time periods, depending on the type of legumes and cereals until the same degree of tenderness of each was achieved.

### *Cooking procedures*

Conventional cooking; fresh samples and cereals were put in flat bottom flasks fitted with air condensers. Tap water (1 g: 4 ml) was added and the fresh vegetable samples were cooked on a hot plate.

Pressure cooking; the samples were placed in 1L beakers containing water (1 g: 4 ml). Tops of the beakers were covered with aluminium foil and then cooked in a pressure cooker at 121$^{o}$C and 1 bar pressure.

Microwave cooking; the samples were placed in 1 L beakers containing water (1 g: 4 ml) and cooked in a domestic microwave oven (Arçelik, Turkey).

In order to achieve a uniform degree of tenderness, the legume and cereal samples were cooked for different time periods.

After each cooking, excess water was drained off and then homogenized in a domestic electric grinder (Bosch) before drying in a hot-air oven (Nüve, Turkey) at 55$^{o}$C for 24 h.

Raw and processed samples were ground in a Wiley mill to pass through a 40-mesh screen before chemical analysis.

### *Acid detergent fibre (ADF), Neutral detergent fibre (NDF) and hemicellulose analyses*

The method of Van Soest and Wine (1967) and McQueen and Nicholson (1979) were used to determine ADF and hemicellulose in samples by Dietary fiber analyser (Velp, Tetra, Türkiye). Neutral detergent fiber was determined by the method of Van Soest and Wine (1967) with enzyme addition. The enzymatic-modification was as follows: 50 ml phosphate buffer (pH 6.0) within 0.1 ml heat-stable alpha-amylase (Termamyl, Sigma) was added and a preliminary overnight incubation with bacterial alpha amylase was employed to remove starch. Hemicellulose was estimated by the difference between NDF and ADF.

Triplicate determinations of all samples were performed for all parameters on dry basis. Statistical analysis data of raw and cooked samples were recorded and standard deviations were calculated. Duncan's and Tukey's multiple range test was used to determine significant difference.

## RESULTS and DISCUSSION

Data on the effect of different cooking methods on ADF, NDF and hemicellulose contents of various food samples are presented in Table 1 as the percentage of each dietary fibre component on a dry basis (%).

The raw vegetables contained 10.8-34.2% NDF and 9.2-28.2% ADF, whereas the amounts hemicellulose contents were 1.2-6%, respectively. NDF values of vegetables for conventional, pressure and microwave cooking were ranged 8.8-29.6, 8.1-26.5, 9.1-28%, respectively. The contents of NDF and ADF of each sample were reduced on cooking, mean values in a row with different letters are significantly different at $P<0.05$ (Table 1). Pressure cooking caused more reduction in ADF, NDF and hemicellulose contents than conventional and microwave cooking.

ADF and hemicellulose contents of vegetables for conventional, pressure and microwave cooking were ranged 8.6-25%, 8.1-23%, 8.9-23.7%, 1.2-4.6%, 0.6-3.5% and 0.6-4.3%, respectively. The results of present study were similar reported Rehman et al. (2003). NDF, ADF and hemicellulose contents for raw legumes and cereals were ranged 9.2-30.1%, 7.6-21.5%, 1.9-20.6%, respectively. The results for raw legumes were similar with the results of Rehinan et al. (2004). The values for conventional, pressure and microwave cooking of NDF, ADF and hemicellulose contents for legumes and cereals were ranged 7.4-23.1%, 6.1-21.6%, 7.1-23.3%, 6.1-20%, 5.2-20%, 5.9-20.5%, and 1.3-16.2%, 0.9-12.9%, 1.2-16.5%, respectively.

Table1. Effect of different cooking methods on ADF, NDF and hemicellulose contents of various food samples

| | NDF (% dry basis) | | | | ADF (% dry basis) | | | | Hemicellulose (% dry basis) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fresh vegetables | Raw | C.* cooking | Pressure cooking | Microwave cooking | Raw | C. cooking | Pressure cooking | Microwave cooking | Raw | C. cooking | Pressure cooking | Microwave cooking |
| Cabbage | $15.1^{a}$ | $12.1^{b}$ | $11.1^{b}$ | $12.6^{ab}$ | 12.1 | 10.2 | 9.6 | 10.6 | $3^{a}$ | $1.9^{b}$ | $1.5^{b}$ | $2.1^{b}$ |
| Leek | $10.8^{a}$ | $8.8^{b}$ | $8.1^{b}$ | $9.1^{ab}$ | 9.2 | 8.6 | 8.1 | 8.9 | 1.6 | 1.2 | 0.7 | 1 |
| Carrot | $14.5^{a}$ | $12.6^{b}$ | $11^{c}$ | $11.5^{c}$ | $12.1^{a}$ | $11.3^{ab}$ | $10.4^{b}$ | $10.9^{b}$ | $2.4^{a}$ | $1.3^{b}$ | $0.6^{b}$ | $0.8^{b}$ |
| Potatoes | $15.3^{a}$ | $13.1^{b}$ | $9.5^{d}$ | $10.9^{c}$ | $11.9^{a}$ | $10.7^{ab}$ | $8.4^{c}$ | $9.8^{bc}$ | $3.4^{a}$ | $2.4^{b}$ | $1.1^{c}$ | $1.2^{c}$ |
| French bean | $12.1^{a}$ | $11.0^{ab}$ | $10.3^{b}$ | $11.3^{ab}$ | $10.9^{a}$ | 10.1 | $9.6^{b}$ | $10.5^{b}$ | 1.2 | 0.9 | 0.7 | 0.8 |
| Green pea | $34.2^{a}$ | $29.6^{b}$ | $26.5^{c}$ | $28.0^{bc}$ | $28.2^{a}$ | $25.0^{ab}$ | $23.0^{b}$ | $23.7^{ab}$ | $6^{a}$ | $4.6^{b}$ | $3.5^{a}$ | $4.3^{a}$ |
| Broad bean | $22.7^{a}$ | $20.8^{b}$ | $20.1^{b}$ | $21.2^{ab}$ | $19.8^{a}$ | $18.6^{c}$ | $18.2^{d}$ | $19.1^{b}$ | $2.9^{a}$ | $2.3^{b}$ | $1.9^{c}$ | $2.1^{bc}$ |
| Spinach | $18.7^{a}$ | $17.8^{b}$ | $16.4^{c}$ | $17.2^{bc}$ | $17.5^{a}$ | $16.9^{ab}$ | $15.6^{c}$ | $16.6^{b}$ | $1.2^{a}$ | $0.9^{b}$ | $0.9^{b}$ | $0.6^{c}$ |
| Cereals | | | | | | | | | | | | |
| Kidney bean | $28.2^{a}$ | $22.6^{bc}$ | $20.0^{c}$ | $22.9^{b}$ | $7.6^{a}$ | $6.4^{b}$ | $6.0^{c}$ | $6.0^{b}$ | 20.6 | 16.2 | 14 | 16.2 |
| Lentil | $30.1^{a}$ | $23.1^{c}$ | $21.2^{d}$ | $23.3^{b}$ | $9.6^{a}$ | $8.6^{b}$ | $8.3^{b}$ | $8.8^{b}$ | $20.5^{a}$ | $14.5^{bc}$ | $12.9^{c}$ | $14.5^{b}$ |
| Bean | $25.3^{a}$ | $17.2^{b}$ | $15.9^{b}$ | $18.2^{b}$ | $9.3^{a}$ | $8.6^{b}$ | $8.3^{b}$ | $8.4^{b}$ | 16 | 8.6 | 7.6 | 7.8 |
| Chickpea | $26.1^{a}$ | $21.0^{b}$ | $17.3^{c}$ | $21.1^{b}$ | $9.5^{a}$ | $7.9^{b}$ | $7.3^{c}$ | $8.1^{b}$ | $16.6^{a}$ | $13.1^{bc}$ | $10^{c}$ | $13^{b}$ |
| Maize | 23.9 | 22.1 | 21.6 | 22.4 | 21.5 | 20.0 | 20.0 | 20.5 | $2.4^{a}$ | $2.1^{b}$ | $1.6^{c}$ | $1.9^{bc}$ |
| Rice | $9.2^{a}$ | $7.4^{b}$ | $6.1^{c}$ | $7.1^{b}$ | $7.3^{a}$ | $6.1^{b}$ | $5.2^{d}$ | $5.9^{c}$ | $1.9^{a}$ | $1.3^{b}$ | $0.9^{c}$ | $1.2^{b}$ |

*C. cooking: conventional cooking
Mean values in a row with different letters are significantly different at $P<0.05$.

Insoluble dietary fibre components of the fresh vegetables, legume and cereal samples were lost to various extents, depending on the type of cooking method. Ordinary or microwave cooking could be minimized the losses of insoluble dietary fibre components instead of a pressure-cooker.

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