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TECHNOLOGICAL AND CHEMICAL STUDIES ON LENTIL (*LENS CULINARIS L.*)

Ghada H.H.Ismail^{1*} and Rama O.²

^{1*} Food Technology Research Institute (FTRI) ,
Agricultural Research Center (ARC) , Giza, Egypt. ²
soil,water and environment Research Institute
(SWERI) , Agricultural Research Center (ARC) ,
Giza, Egypt.

ABSTRACT

Lentil is widely grown and are consumed as a source of plant protein throughout the world and contain a high value of fiber and carbohydrate and a lowest value of fat . They rank second after cereals with respect to their consumption order. Legumes have antinutritional factors which make their uses limited. In this study lintel seed were procedure with four treatments profile raw lentil , soaky lentil cooked raw lentil and cooked soaky lentil and aims to check the effect of soaking and cooking on the anti-nutrient contents and nutritional quality of the lentil. After soaking and cooking, legumes were tested for anti-nutrients (phytic acid and tannin) and their nutritional quality. Findings – The statistical analysis of the study results revealed that there has been increasing scientific interest in the study area of lentils as the functional food due to its high nutritive value, polyphenols, and some bioactive compounds. Soaking and cooking of legumes result in significant reduction in phytic acid and tannin contents.

Key words: antinutritional factors, bioactive compounds, lentil , soaking and cooking .

INTRODUCTION

Leguminous plants that produce edible part are referred to as food legumes. The word pulse is used to describe legumes that bear edible dry seed that is directly used by man. Family leguminaceae consist of 600 genera and 13,000 species (**Aykroyd and Doughty, 1964**). Legumes are widely grown and consumed as a source of plant protein throughout the world. These are considered as one of the cheapest and richest source of dietary protein, which are used as a substitute or supplement in the relatively expensive animal protein in human diet. Beside proteins, carbohydrates, minerals and vitamins are also present in legumes (**Wolf, 1988**). Protein contents of legumes vary between 17 and 34 per cent, which include metabolic, structural and storage protein. Storage protein is made up to 80 per cent of the total protein (**Sgarbieri and Whitaker, 1982**). Lipid content is in the range of 1-6 per cent and mainly depends upon variety, origin, location of growth, climate, season, environmental factors and soil type (**Worthington et al., 1972**). Lipids found in legumes are mainly neutral lipids i.e. triglycerids, di and monoglycerides, free fatty acids, sterols and sterol esters. Major carbohydrates in legumes are starch and numerous others sugars. Sugars ranges between 6 and 12 per cent, whereas starch vary from 24 to 41 per cent. Peas and bean are poor source of aft soluble vitamin but contain moderate amount of water soluble. Peas and beans are high in phosphorous and very low in sodium. Phosphorous is second highest mineral that exist in several forms. In chickpea, phosphorous is distributed as acid soluble (74 per cent), inorganic (11 per cent), phytates (45 per cent), phospholipids (16 per cent) and others (10 per cent) (**Wolf, 1988**).

Legumes are rank second after cereals with respect to their consumption order and widely grown and are consumed as a source of plant protein throughout the world. They rank second after cereals with respect to their consumption order. Legumes have anti-nutritional factors which make their uses limited. This study aims to check the effect of soaking and cooking on the anti-nutrient contents and nutritional quality of the legumes. Design / methodology / approach – Five legumes (white kidney bean, red kidney bean, lentil, chickpea, and white gram) frequently used by the masses were selected for soaking and cooking trials. Legumes were tested for their weight, volume, density, swelling capacity and water absorption capacity before soaking and cooking. Legumes were soaked in simple water, 2 per cent sodium chloride solution, acetic acid and sodium bicarbonate and cooked in a beaker with

1 : 5 seed water ratio to uniform soft mass. After soaking and cooking, legumes were tested for anti-nutrients (phytic acid and tannin) and their nutritional quality. Findings – The statistical analysis of the study results revealed that dark color legume (red kidney beans) has a high level of phytic acid and tannin compared with light color (white kidney beans and white grams). Soaking and cooking of legumes result in significant reduction in phytic acid and tannin contents. Maximum reduction of phytic acid (78.055) and tannin (65.81 per cent) was found for sodium bicarbonate soaking followed by cooking. These treatments also result in a slight reduction in nutrients such as protein, minerals and total sugars. Practical implications – Soaking and cooking of legumes reduce their anti-nutrients; phytic acid and tannin significantly. These treatments may be used domestically as well as commercially to increase the nutrients' availability from legumes to meet the problem of protein and minerals deficiencies. Originality/value – Along with water different soaking solutions which are easily available in the market were used to test out their effect on the nutritional quality and safety. These may be used by the common people to raise their nutritional status (**Huma et al., 2008**).

Lentil (*Lens culinaris*; Family: Fabaceae) is a potential functional dietary ingredient which has polyphenol-rich content. Several studies have demonstrated that the consumption of lentil is immensely connected to the reduction in the incidence of diseases such as diabetes, obesity, cancers and cardiovascular diseases due to its bioactive compounds. There has been increasing scientific interest in the study area of lentils as the functional food due to its high nutritive value, polyphenols, and other bioactive compounds. These polyphenols and the bioactive compounds found in lentil play an important role in the prevention of those degenerative diseases in humans. Besides that, it has health-promoting effects. Based on the in vitro, in-vivo and clinical studies, the present review focuses to provide more information on the nutritional compositions, bioactive compounds including polyphenols and health-promoting effects of lentils. Health-promoting information was gathered and orchestrated at a suitable place in the review (**Ganesan and Baojun , 2017**). Lentil (*Lens culinaris*) is a leguminous plant high in fibre and low in fat. As demonstrated by (**Brummer et al. (2015)**) lentil is richer in total soluble fibre than peas and chickpeas. Also, its content of dietary fibre is higher than beans and chickpeas. Like most legumes, lentil is a rich source of protein, having between 20.6% and 31.4% proteins (**Urbano et al., 2007**). Most of these are storage proteins located in the cotyledon, containing a low percentage of sulphur-containing amino acids.

This investigation was aimed to check the effect of soaking and cooking on the anti-nutrient contents and nutritional quality of the lentil.

MATERIALS AND METHODS

Materials:

Brown lintels were obtained from Field Crops Research Institute (FCRI) , Agricultural Research Center (ARC) , Giza, Egypt.

Methods:

Soaking of Lintel:

Brown lintel manually cleaned, billed , wash and soaked in distilled water 30m and filtration to produce to the chemical and technological studies.

Cooking time:

Pre-soaked whole seeds and raw were cooked one to one in a beaker in water five times to the samples were periodically checked for their softness by pressing them between thumb fingers. Samples were considered cooked when soft to uniform mass (**Huma et al., 2008**).

Chemical analysis:

Moisture , protein , ash, crude fiber, crude fat, carbohydrate and total sugars were determined according to the methods described in the (**A.O.A.C., 2000**). Minerals were determined by the method described by (**Summerfield and Muehlbauer,1982**). Bioavalability of iron determined by method described by (**Sandberg and Svanberg 1991**). Total phenols and flavonoids contents were described by (**Arnous et al. ,2001**) and (**Joyeux et al. ,1995**), respectively. Antioxidant activity was determined by the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) method according to (**Brand-Williams et al., 1995**). Oxygen radical absorbing capacity (ORAC) was determined according to the methods described by (**Swieca and Gawlik-Dziki, 2015**). Vitamins were determined by method described by (**Padovani et al. ,2007**). Polyphenols and flavonoids contents were determined using HPLC (Agilent series 1200). Column temperature was maintained at 35°C. gradient separation was carried out with methanol and acetonitrile as a mobile phase at flow rate of 1 ml/min. This method modified of (**Goupy et al., 1999**) and (**mattilla et al., 2000**), respectively. Phytic acid contents of legumes samples were determined by the method described by (**Ayet et al., 1997**). Tannins contents was determined by vanillin hydrochloric acid method described by

(Vaillancourt and Slinkard 1985). Amino acids determined by method described by (Sulser and Sager,1976).

Statistical analysis

The obtained data were exposed analysis of variance. Duncan's Multiple range tests at ($p \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO-ANOVA procedure of Statistical Analysis System SAS.

RESULTS AND DISCUSSION

Data presented in **Table (1)**, show the chemical composition of lentil treatment, it could be demonstrated that raw lentil contained the highest values in protein and fat ranged from 28.8 and 2.90, respectively , whereas cooked soaky lentil and cooked raw lentil have the highest values in moisture and fiber had 60.93 , 3.89 and 60.70 , 3.80 g/100g , respectively . On the other hand cooked soaky lentil contained the lowest values of protein had 20.0 g/100g while soaky lentil have the lowest values of fiber which was 3.15 g/100g .

Table (1): Nutrient content of lentil treatments g/100 g.

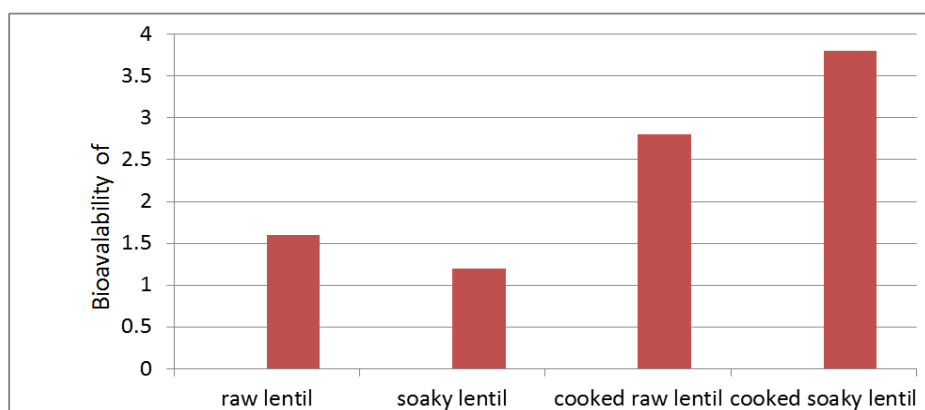
Nutrient	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Moisture	10.0 ^d	30.91 ^c	60.70 ^b	69.93 ^a
Ash	0.30 ^b	3.76 ^a	3.60 ^a	3.40 ^b
Protein	28.8 ^a	20.88 ^c	26.5 ^b	20.0 ^d
Fiber	3.60 ^b	3.15 ^c	3.80 ^a	3.89 ^a
Sugar	2.35 ^b	2.57 ^a	2.32 ^{ab}	2.81 ^a
Carbohydrate	60.3 ^a	16.3 ^b	17.3 ^b	10.3 ^c
Fat	2.90 ^a	2.57 ^c	2.70 ^b	2.10 ^d

The results presented in **Table (2)** show the mineral content of lentil treatments, it could be noticed that the mineral content of lentil treatments, cooked raw lentil had the highest content in iron (Fe) , calcium (Ca) , Potassium (K) and magnesium (Mg) ranged from 9.5, 64.2, 964 and 1.32 mg/100g, respectively followed by raw lentil ranged from 7.5, 56, 955 and 1.3, respectively mg/100g .Also raw lentil contained the highest value of zinc rang was 4.8, respectively mg/100g followed by cooked raw lentil 3.1 mg/100g , cooked soaky lentil 2.0 mg/100g and soaky lentil 1.8 mg/100g .

Table (2):mineral contant of lentil treatments mg/100g.

Mineral	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Iron (Fe)	7.5 ^a	6.52 ^b	9.5 ^a	6.40 ^b
Calcium (Ca)	56 ^b	34 ^d	64.2 ^a	49.0 ^c
Potassium (K)	955 ^b	900 ^d	964 ^a	920 ^c
Zinc (Zn)	4.8 ^a	1.8 ^d	3.10 ^b	2.00 ^c
Magnesium (Mg)	1.3 ^a	1.01 ^c	1.32 ^a	1.25 ^b

Bioavalability of iron in lintil treatments under investigation presented in **Figure (1)**.

**Fig. (1) : Bioavalability of iron in lentil treatments.**

The antioxidant Potential of lentil treatments under investigation are presented in **Table (3)**, it was noticed that the raw lentil had the highest value of total phenols , DPPH and Oxygen radical capacity ranged from 100, 65.0 and 1.56, respectively but the highest value of total flavonoids was in cooked soaky lentil 1.99mg/g. On the other hand the cooked soaky lentil sample recorded the highest value of total phenols , flavonoids , DPPH and oxygen radical capacity of the cooked lentil samples ranged from 67.0, 1.99, 63.0 and 1.42, respectively .

Table (3): Antioxidant Potential of lentil treatments.

Test	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Total phenols mg/g	100.0 ^a	60.0 ^c	50.0 ^d	67.0 ^b
Total flavonoids mg/g	1.85 ^b	1.30 ^d	1.64 ^c	1.99 ^a
DPPH %	65.0 ^a	62.0 ^b	43.0 ^c	63.0 ^b
Oxygen radical capacity%	1.56 ^a	1.50 ^b	1.34 ^c	1.42 ^b

From the results presented in **Table (4)** , it could be noticed that the soaky lentil contain the highest value of vitamins component Thiamine, Riboflavin, Niacin, Folate, Vitamin A and Tocopherol ranged from 7.32, 4.98, 97.0, 80.0, 6.33 and 8.50, respectively followed by raw lentil was thiamine 6.3 mg/g, riboflavin 4.09 mg/g , niacin 112 mg/g, folate 19.0 mg/g , vitamin A 5.00 IU and tocopherol 6.90 mg/g, respectively . whereas the cooked raw lentil was a perfect treatment in vitamins Niacin and Folate were 42.83 and 12.09 mg/g , respectively, but the cooked raw lentil was higher than cooked soaky lentil in riboflavin and tocopherol were 2.34 and 9.88 mg/g , respectively.

Table (4): Vitamins component of lentil treatments.

Vitamins component	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Thiamine mg/g	6.30 ^b	7.32 ^a	5.34 ^d	3.44 ^c
Riboflavin mg/g	4.09 ^a	4.98 ^a	2.34 ^b	1.23 ^c
Niacin mg/g	112 ^a	97.0 ^b	16.33 ^d	42.83 ^c
Folate mg/g	19.0 ^a	80.0 ^b	7.09 ^d	12.09 ^c
Vitamin A IU	5.00 ^a	6.33 ^b	3.09 ^c	4.88 ^c
Tocopherol mg/g	6.90 ^a	8.50 ^a	9.88 ^a	6.88 ^a

Legumes have anti-nutritional factors which make their uses limited. Results mentioned in **Table (5)** show the anti-nutrients of lentil treatments, it could be observed that cooked soaky lentil had the lowest content in anti-nutrients of lentil treatments ranged from 315 and 612 mg/100g, respectively followed by soaky lentil ranged from 413 and 610 mg/100g, respectively , but the cooked raw lentil had the highest content in anti-nutrients of lentil treatments ranged from 710 and 881 mg/100g , respectively. In this context, research was designed to find out the effect of soaking and cooking on the nutritional quality of legumes and best quality of nutrition.

Table (5): Anti-nutrients of lentil treatments mg/100g.

Test	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Phytic acid	640 ^b	413 ^c	710 ^a	315 ^d
Tannins	870 ^a	610 ^c	881 ^b	612 ^c

Soaking and cooking of lentil reducing the anti-nutritional factors, from the results presented in **Table (6)** and **Figure (2)** , it could be noticed that the cooked soaky lentil recorded the highest value in amino acid composition in methionine, tyrosine, leucine, tryptophan, histidine and Phenylalanine ranged from 4.58, 3.50, 7.91, 1.50, 1.87 and 0.42 mg/g , respectively followed by cooked raw lentil in valine and histidine ranged from 2.56 and 1.38 mg/g, respectively.

Table (6): Amino acid composition of lentil treatments mg/g:

Amino acid	Raw lentil	Soaky lentil	Cooked raw lentil	Cooked soaky lentil
Valine	3.56	2.18	2.56	2.06
Methionine	1.07	0.09	1.98	4.58
Tyrosine	3.84	2.09	2.56	3.50
Leucine	6.83	5.80	6.01	7.91
Tryptophan	1.30	0.04	0.80	1.50
Lysine	4.91	2.07	4.24	3.45
Histidine	1.61	1.10	1.38	1.87
Phenylalanine	0.58	0.00	0.34	0.42

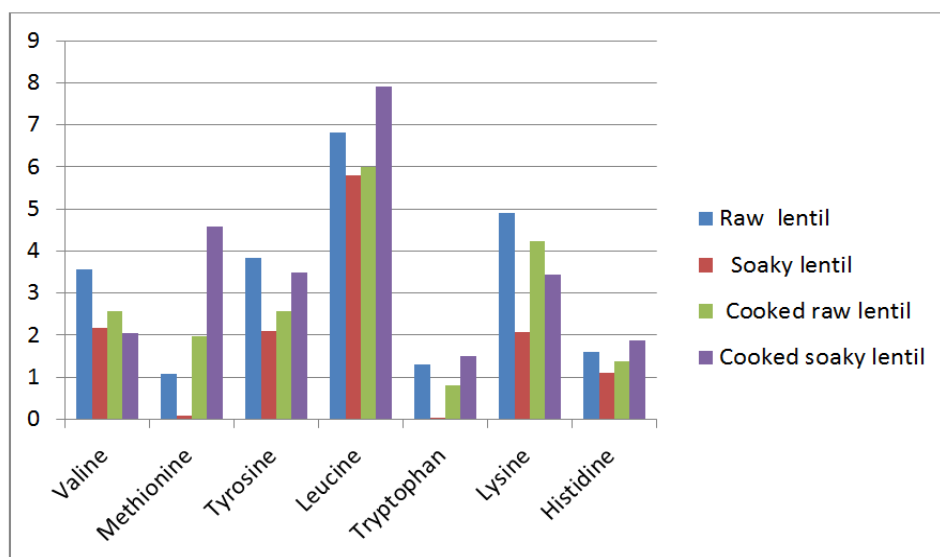


Fig (2): Amino acid composition of lentil treatments mg/g.

Conclusions

Lentils have been consumed as a part of the diet world wide and play a significant function in human nutrition as a rich source of bioactive component. lentils have the highest of protein , carbohydrates and fiber contents . Lentils are among the cost-effective legumes, and they have lower quantities of fat and contain of bioactive vitamins. This study demonstrates them as a health-promoting source of nutrients and their intake in the daily diet should increase and the soaking and cooking of lentil increase utilization of iron , improvement of some vitamins and nutritional quality.

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دراسات كيميائية و تكنولوجيه على العدس

غادة حسين حامد إسماعيل و راما طلعت

معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية

معهد بحوث الاراضى والمياه – مركز البحوث الزراعية

العدس ينمو على مدى واسع من العالم و تستهلك كمصدر بروتين نباتى على القيمة الغذائية و نسبة عاليه من الالياف و الكربوهيدرات و نسبة قليله من الدهون و يحتوى على العديد من المركبات الفعاله مثل الفينولات و الفلافونيدات و الفيتامينات و لكن يحتوى على عوامل مضادة للتغذية تعوق من الاستفادة من المغذيات الموجوده به. لذلك فى هذه الدراسه تم تقييم العدس فى أربع صور (العدس الخام – العدس المنقوع – العدس الخام المطبوخ – العدس المنقوع المطبوخ) وإجراء الأختبارات على هذه المعاملات لمعرفة تأثيرها على العوامل المضادة للتغذية و الجودة الغذائية . و أشارت نتائج الدراسه إلى ان معاملة النقع و الطبخ تحسن من الجوده الغذائية و تقلل من العوامل المضادة للتغذية مثل (الفيتيك اسيد و التانينات) .