CAIRO UNIVERSITY
INSTITUTE OF AFRICAN RESEARCH AND STUDIES

AFRICAN STUDIES REVIEW

* Effect of Blanching and Freezing on Nutritive Value of Some Vegetables in Sudan
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ISSUE 36 2014

Cairo Univ. Stud. Rev. Vol. (36) (2014) : 13 - 24

Nutritive Value of Some Fresh Vegetables Used in Food Processing in Sudan

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Abstract :

This study was intended to investigate the nutritional value (moisture, protein, fat, carbohydrate, fiber, ash, ascorbic acid and minerals) for five types of fresh vegetables (okra, green beans, peas, spinach and molokhia), which use in food processing. The results of okra showed 83.87% moisture, 1.42% protein, 0.46% fat, 7.54% carbohydrate, 5.92% fiber, 0.79% ash, 38.13 mg/100g ascorbic acid, 226.27 mg/100g sodium, 794.31 mg/100g potassium, 402.56 mg/100g calcium and 678.72 mg/100g magnesium content. The results of green beans showed 86.52% moisture, 1.82% protein, 0.43% fat, 5.06% carbohydrate, 6.31% fiber, 0.86% ash, 56.32 mg/100g ascorbic acid, 127.03 mg/100g sodium, 712.43 mg/100g potassium, 407.65 mg/100g calcium and 637.18 mg/100g magnesium content. The results of peas showed 83.43% moisture, 1.93% protein, 0.47% fat, 6.98% carbohydrate, 6.42% fiber, 0.77% ash, 45.68 mg/100g ascorbic acid, 218.63 mg/100g sodium, 596.81 mg/100g potassium, 407.57 mg/100g cal-

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cium and 564.45 mg/100g magnesium content. The results of spinach showed 83.86% moisture, 1.84% protein, 0.53% fat, 6.83% carbohydrate, 6.11% fiber, 0.83% ash, 52.47 mg/100g ascorbic acid, 269.42 mg/100g sodium, 795.46 mg/100g potassium, 603.57 mg/100g calcium and 672.24 mg/100g magnesium content. Molokhia had 84.78% moisture, 1.46% protein, 0.57% fat, 6.54% carbohydrate, 5.64% fiber, 0.87% ash, 48.22 mg/100g ascorbic acid, 163.48 mg/100g sodium, 823.83 mg/100gm potassium, 208.65 mg/100g calcium and 783.26 mg/100g magnesium content.

Key words: vegetables; moisture; protein; fat; carbohydrate; fiber; ash; ascorbic acid content; potassium; sodium; calcium; magnesium

INTRODUCTION

An inverse relationship between the consumption of fresh vegetables and numerous diseases has been demonstrated in many intervention studies **(Sipos et al., 2009)**. For example, studies have shown the relationship between a high risk of cardiovascular disease or certain kinds of cancer with a low intake of β-carotene, or flavonoids **(Kritchevsk, 1999; Neuhuser, 2004 and Arts and Hollman 2005)**. Epidemiological studies also revealed that whole vegetables were more efficient than its purified chemical component in reducing risk of diseases **(Holick et al. 2002)**. The difference between fresh whole vegetables with pure chemical component supplementation may be due to the interaction between bioactive components in the whole vegetables **(Burri, 1997)**. Moreover, many phytochemicals have recondite effects on human health which is dependent on their doses and this may in part explain the conflicting findings from epidemiological studies **(Arts and Hollman 2005)**. More detailed and unbiased intervention trails are needed to measure the beneficial effects and/or the optimum dosage of certain phytochemicals on humans **(Sahreen et al., 2010)**.

Besides the positive effects on human health, bioactive compounds themselves may affect shelf life of fresh product. **Bergquist et al. (2006)** found that vegetables, when harvested a few days earlier, had higher ascorbic acid, exhibited improved visual quality and better nutritional value during storage **(Sipos et al., 2009)**. Higher concentration of antioxidants at harvest ensured the ability of vegetables to reduce oxidative stress during subsequent storage **(Hodges et al. 2004)**. It may thus be postulated that high concentrations of antioxidants can better protect fresh product against oxidative stress and the onset of senescence. Thus, increasing the content of bioactive compounds in vegetables at harvest may not only have beneficial effects on human health, but may also improve the appearance, prolong shelf life, and reduce post-harvest losses of fresh produce **(Sahreen et al., 2010)**.

MATERIALS AND METHODS

Samples preparation

The fresh vegetables samples were collected from local market and the fresh samples were washed under running tap water and kept on 4 °C until needed of analysis. Also, another vegetables samples were collected after blanching and freezing and kept on -18 °C until needed for the different investigations. Moreover, all the chemicals used in this study were of analytical grade.

Chemical composition

Moisture, protein, fat, fiber and ash were determined according to **AOAC (2010)**. The carbohydrate content was calculated by difference. Ascorbic acid was determined according to **Ruck method (1963)** in the manner described by **El-obeid (2003)**, and minerals were detected according to **Pearson's method (1981)**, potassium and sodium contents of were determined according to **AOAC (2010)** using Flame

photometer, calcium content was determined according to **Champman and Pratt (1968)**, magnesium content was determined according to **Pearson's method (1981)** with some modifications.

RESULTS AND DISCUSSION

Moisture content

Moisture content of okra sample was 83.87%, of green beans sample was 86.52%, of peas sample was 83.43%, of spinach sample was 83.86%, while, of molokhia sample was 84.78%.

Protein content

Protein content of okra sample was 1.42%, of green beans sample was 1.82%, of peas sample was 1.93%, of spinach sample was 1.84%, while, of molokhia sample was 1.46%.

Fat content

Fat content of okra sample was 0.46%, of green beans sample was 0.43%, of peas sample was 0.47%, of spinach sample was 0.53%, while, of molokhia sample was 0.57%.

Carbohydrate content

Carbohydrate content of okra sample was 7.54%, of green beans sample was 5.06%, of peas sample was 6.98%, of spinach sample was 6.83%, while, of molokhia sample was 6.54%.

Fiber content

Fiber content of okra sample was 5.92%, of green beans sample was 6.31%, of peas sample was 6.42%, of spinach sample was 6.11%, while, of molokhia sample was 5.64%.

Ash content

Ash content of okra sample was 0.79%, of green beans sam-

ple was 0.86%, of peas sample was 0.77%, of spinach sample was 0.83%, while, of molokhia sample was 0.87%.

Ascorbic acid content

Ascorbic acid content of okra sample was 38.13 mg/100g, of green beans sample was 56.32 mg/100g, of peas sample was 45.68 mg/100g, of spinach sample was 52.47 mg/100g, while, of molokhia sample was 48.22 mg/100g.

Sodium content

Sodium content of okra sample was 226.27 mg/100g, of green beans sample was 127.03 mg/100g, of peas sample was 218.63 mg/100g, of spinach sample was 269.42 mg/100g, while, of molokhia sample was 163.48 mg/100g.

Potassium content

Potassium content of okra sample was 794.31 mg/100g, of green beans sample was 712.43 mg/100g, of peas sample was 596.81 mg/100g, of spinach sample was 795.46 mg/100g, while, of molokhia sample was 823.83 mg/100gm.

Calcium content

Calcium content of okra sample was 402.56 mg/100g, of green beans sample was 407.65, of peas sample was 407.57, of spinach sample was 603.57 mg/100g, while, of molokhia sample was 208.65 mg/100g.

Magnesium content

Magnesium content of okra sample was 678.72 mg/100g, of green beans sample was 637.18 mg/100g, of peas sample was 564.45 mg/100g, of spinach sample was 672.24 mg/100g, while, of molokhia sample was 783.26 mg/100g.

Table 1: Nutritional value of fresh okra

Item	Content
Moisture %	83.87 ± 0.01
Protein %	1.42 ± 0.03
Fat %	0.46 ± 0.01
Carbohydrate %	7.54 ± 0.05
Fiber %	5.92 ± 0.06
Ash %	0.79 ± 0.03
Vitamin C mg/100g	38.13 ± 0.06
Sodium mg/100g	226.27 ± 0.01
Potassium mg/100g	794.31 ± 0.03
Calcium mg/100g	402.56 ± 0.04
Magnesium mg/100g	678.72 ± 0.01

Table 2: Nutritional value of fresh green beans

Item	Content
Moisture %	86.52 ± 0.03
Protein %	1.82 ± 0.05
Fat %	0.43 ± 0.03
Carbohydrate %	5.06 ± 0.04
Fiber %	6.31 ± 0.03
Ash %	0.86 ± 0.02
Vitamin C mg/100g	56.32 ± 0.05
Sodium mg/100g	127.03 ± 0.01
Potassium mg/100g	712.43 ± 0.03
Calcium mg/100g	407.65 ± 0.06
Magnesium mg/100g	637.18 ± 0.01

Table 3: Nutritional value of fresh peas

Item	Content
Moisture %	83.43 ± 0.03
Protein %	1.93 ± 0.06
Fat %	0.47 ± 0.01
Carbohydrate %	6.98 ± 0.06
Fiber %	6.42 ± 0.03
Ash %	0.77 ± 0.04
Vitamin C mg/100g	45.68 ± 0.03
Sodium mg/100g	218.63 ± 0.02
Potassium mg/100g	596.81 ± 0.04
Calcium mg/100g	407.57 ± 0.06
Magnesium mg/100g	564.45 ± 0.03

Table 4: Nutritional value of fresh spinach

Item	Content
Moisture %	83.86 ± 0.01
Protein %	1.84 ± 0.03
Fat %	0.53 ± 0.01
Carbohydrate %	6.83 ± 0.04
Fiber %	6.11 ± 0.02
Ash %	0.83 ± 0.04
Vitamin C mg/100g	52.47 ± 0.01
Sodium mg/100g	269.42 ± 0.06
Potassium mg/100g	795.46 ± 0.02
Calcium mg/100g	603.57 ± 0.06
Magnesium mg/100g	672.24 ± 0.02

Table 5: Nutritional value of fresh molokhia

Item	Content
Moisture %	84.78 ± 0.04
Protein %	1.46 ± 0.03
Fat %	0.57 ± 0.02
Carbohydrate %	6.54 ± 0.01
Fiber %	5.64 ± 0.04
Ash %	0.87 ± 0.03
Vitamin C mg/100g	48.22 ± 0.05
Sodium mg/100g	163.48 ± 0.03
Potassium mg/100g	823.83 ± 0.04
Calcium mg/100g	208.65 ± 0.05
Magnesium mg/100g	783.26 ± 0.01

Some of the bioactive compounds in vegetables are ubiquitous while others are unique to specific families, species, or even cultivars. Ascorbic acid and phenolic compounds are found in many vegetables but the concentrations vary among them **(Kevers et al., 2007 and Lin and Tang 2007)**. Flavonoid content has been shown to differ among vegetables genotypes **(Cho et al., 2008)**, and the flavonoid glycosides identified in some vegetables are rare and some are not present in other vegetables **(Bergquist et al., 2005)**. Thus, genetic factors have significant influences on the composition of bioactive compounds in fresh products.

A number of pre-harvest factors such as temperature and light intensity during growth, water supply and soil characteristics affect the concentration of bioactive compounds in vegetables **(Ferguson et al., 1999)**. For example, environmental conditions, such as air temperature **(Lefsrud et al., 2005)** and light condition **(Bergquist et al. 2007a)**, affect the chemical composition in vegetables. Shade netting decreased ascorbic acid concentration but increased the carotenoid content in vegetables **(Bergquist et al. 2007b)**. Nutrient availability and soil type may also affect bioactive compounds **(Weston and Barth 1997)**.

Growth stage and maturity also affect the concentration of bioactive compounds. Mid-mature vegetables have higher total phenolics and flavonoids than immature and more mature vegetables **(Pandjaitan et al., 2005)**, whereas the highest ascorbic acid content was found in immature vegetables **(Bergquist et al., 2006)**. Carotenoid and/or flavonoids accumulate during vegetables ripening to provide color to the ripe vegetables **(Kalt, 2005). Reyes et al. (2007)** reported that mechanical injuries at harvest may increase antioxidant content in product. Moreover, the harvest time during the day may result in significant changes in concentration of bioactive compounds, possibly related with light intensity and water content **(Veit et al., 1996)**.

REFERENCES

- **AOAC, (2010)**. Official Methods of Analysis, **Association of Official Analytical Chemists, Inc., USA**.
- **Arts, I. and Hollman, P. (2005)**. Polyphenols and disease risk in epidemiologic studies. **Am J Clin Nutr, 81: 317S-325S**.
- **Champman, H. D. and Pratt, F. P., (1968).** Ammonium molybdate – Ammonium vanadate method for determination of phosphorus, Methods of analysis of soil, plants and water. **California University, public division of agric. Sci., pp. 169-170**.
- **Cho, M., Howard, L., Prior, R. and Morelock, T. (2008).** Flavonoid content and antioxidant capacity of spinach genotypes determined by high-performance liquid chromatography/mass spectrometry. **J Sci Food Agric, 88: 1099-1106**.
- **Bergquist, S., Gertsson, U., Knuthsen, P. and Olsson, M. (2005).** Flavonoids in baby spinach (*Spinacia oleracea L*.): Changes during plant growth and storage . **J Agric Food Chem, 53: 9459-9464**.
- **Bergquist, S., Gertsson, U., Nordmark, L. and Olsson, M. (2007a).** Effects of shade nettings, sowing time and storage on baby spinach flavonoids. **J Sci Food Agric, 87: 2464-2471**.
- **Bergquist, S., Gertsson, U., Nordmark, L. Olsson, M. (2007b).** Ascorbic acid, carotenoids, and visual quality of baby spinach as affected by shade netting and postharvest storage. **J Agric Food Chem, 55: 8444-8451**.
- **Bergquist, S., Gertsson, U. and Olsson, M. (2006).** Influence of growth stage and postharvest storage on ascorbic acid and carotenoid content and visual quality of baby spinach (*Spinacia oleracea L*.). **J Sci Food Agric, 86: 346-35**5.
- **Burri, B. (1997)**. Beta-carotene and human health: A review of current research. **Nutr Res, 17: 547-580**.
- **El-obeid, S.M. (2003).** A biochemical study on dehydrated whole limes (Citrus aurantifdia) for export. **M. Sc. Thesi, Food Science and Technol. Dep. Faculty of Agriculture University of Khartoum, Sudan**.
- **Ferguson. I., Volz, R. and Woolf, A. (1999).** Preharvest factors affecting physiological disorders of fruit. **Postharvest Biol Tec, 15: 255-262**.
- **Hodges, D., Lester, G., Munro, K. and Toivonen, P. (2004).** Oxidative stress: Importance for postharvest quality. **Hort Science, 39: 924-929**.
- **Holick, C., Michaud, D., Stolzenberg-Solomon, R., Mayne, S., Pietinen, P., Taylor, P., Virtamo, J. and Albanes, D. (2002).** Dietary carotenoids, serum beta-carotene, and retinol and risk of lung cancer in the alpha-tocopherol, beta-carotene cohort study. **Am J Epidemiol, 156: 536-547.**

- **Kalt, W. (2005).** Effects of production and processing factors on major fruit and vegetable antioxidants. **J Food Sci, 70: 11-19**.
- **Kevers, C., Falkowski, M., Tabart, J., Defraigne, J., Dommes, J. and Pincemail, J. (2007).** Evaluation of antioxidant capacity during storage of selected fruits and vegetables. **J Agric Food Chem, 55: 8596-8603**.
- **Kritchevsky, S. (1999).** Beta-carotene, carotenoids and the prevention of coronary heart disease. **J Nutr, 129: 5-8**.
- **Lefsrud, M., Kopsell, D., Kopesll, D. and Curran-Celentano, J. (2005).** Air temperature affects biomass and carotenoid pigment accumulation in kale and spinach grown in a controlled environment. **Hortscience, 40: 2026-2030**.
- **Lin, J. and Tang, C. (2007).** Determination of total phenolic and flavonoid contents in selected fruits and vegetables, as well as their stimulatory effects on mouse splenocyte proliferation. **Food Chem, 101: 140-147**.
- **Neuhouser, M. (2004).** Dietary flavonoids and cancer risk: Evidence from human population studies. **Nutr Cancer Int J, 50: 1-7**.
- **Pandjaitan, N., Howard, L., Morelock, T. and Gil, M. (2005).** Antioxidant capacity and phenolic content of spinach as affected by genetics and maturation. **J Agric Food Chem, 53: 8618-8623**.
- **Pearson, D., (1981).** Pearson's Chemical Analysis of Foods. Egan, H., Kirk, R. S. and Sawver, R. (eds) 18th ed., **London, New York**.
- **Reyes, L., Villarreal, J. and Cisneros-Zevallos, L. (2007).** The increase in antioxidant capacity after wounding depends on the type of fruit or vegetable tissue. **Food Chem, 101: 1254-1262**.
- **Ruck, J.A. (1963)**. Chemical method for analysis of fruit and vegetable products. **Dep. Of Agric., Canada**.
- **Wargovich, M. J., (2000).** Anticancer properties of fruits and vegetables. **HortScience 25: 1473-1532**.
- **Sahreen, S., Khan, M., Khan, R. (2010).** Evaluation of antioxidant activities of various solvent extracts of Carissa opaca fruits. Food **Chemistry, 122, 1205–1211**.
- **Sipos, P., Katai, Z., Barancsi, A., Mezei, Z., Borbely, M., Gyori, Z. (2009):** Effect of freezing and desiccation filiations on the biologically active compounds of fruits, Processing and energy, **JDPTEP, 13(3):293-294**.
- **Veit, M., Bilger, T., Muhlbauer, T., Brummet, W. and Winter, K. (1996).** Diurnal changes in flavonoids. **J Plant Physiol, 148: 478-482**.
- **Weston, L. and Barth, M. (1997).** Preharvest factors affecting postharvest quality of vegetables. **HortScience, 32: 812-816**.

القيمة الغذوية لبعض الخضروات الطازجة المستخدمة في التصنيع الغذائي في السودان

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الملخص :

أجريت هذه الدراسة لتحديد القيمة الغذائية (محتوى الرطوبة ، محتوى الرماد، محتوى البروتين، محتوى الدهون، محتوى الكربوهيدات، محتوى الألياف، محتوى حمض الأسكوربيك، محتوى المعادن) لخمسة أنواع من الخضروات الطازجة (البامية، الفاصوليا الخضراء، البسلة، السبانخ والملوخية). أظهرت نتائج البامية ٨٣,٨٧٪ رطوبة، ١,٤٢٪ بروتين، ٠,٤٦٪ دهون، ٧,٥٤٪ كربوهيدات، ٥,٩٢٪ ألياف، ٠,٧٩٪ رماد، ٣٨,١٣ ملجم/١٠٠جم حمض أسكوربيك،٢٢٦,٢٧ ملجم/١٠٠جم صوديوم، ٧٩٤,٣١ ملجم/١٠٠جم بوتاسيوم، ٤٠٢,٥٦ ملجم/١٠٠جم كالسيوم، ٦٧٨,٧٢ ملجم/١٠٠جم ماغنسيوم. أظهرت نتائج الفاصوليا الخضراء ٨٦,٥٢٪ رطوبة، ١,٨٢٪ بروتين، ٠,٤٣٪ دهون، ٥,٠٦٪ كربوهيدات، ٦,٣١٪ ألياف، ٠,٨٦٪ رماد، ٥٦,٣٢ ملجم/١٠٠جم حمض أسكوربيك،١٢٧,٠٣ ملجم/١٠٠جم صوديوم، ٧١٢,٤٣ ملجم/١٠٠جم بوتاسيوم، ٤٠٧,٦٥ ملجم/١٠٠جم كالسيوم، ٦٣٧,١٨ ملجم/١٠٠جم ماغنسيوم. أظهرت نتائج البسلة ٨٣,٤٣٪ رطوبة، ١,٩٣٪ بروتين، ٠,٤٧٪ دهون، ٦,٩٨٪ كربوهيدات، ٦,٤٢٪ ألياف، ٠,٧٧٪

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