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CHEMICAL COMPOSITION OF LEMON (*CITRUS LIMON*) AND PEELS ITS CONSIDERATIONS AS ANIMAL FOOD

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Abstract

Lemon peels utilizable foodstuffs were analysed for crude protein, phosphorus, calcium, copper, manganese, iron, zinc, sodium, potassium and some chemical parameters in feedstuffs. The levels of protein (9.42 %), fat (4.98%), ash (6.26%), fiber (15.18%), sodium (755.5 mg/100g), potassium (8600 mg/100g), calcium (8452.5 mg/100g), copper (4.94 mg/100g), iron (147.65 mg/100g), magnesium (1429.50 mg/100g), zinc (13.94 mg/100g) and phosphorus (6656 mg/100g) detected in the lemon peels were compared with that of Iranian national standard for animal food. The value of fat, crude protein and fiber are comparable to the values for varieties of animal feed reported by Iranian national standard.

Keywords: Lemon peel, animal feed, AAS

LİMON (*CITRUS LIMON*) KABUKLARININ KİMYASAL BİLEŞİMİ VE HAYVAN YEMİ OLARAK DEĞERLENDİRİLMESİ

Özet

Bu çalışmada, limon kabuklarının; bileşimindeki ham protein, fosfor, kalsiyum, bakır, manganez, demir, çinko, sodyum, potasyum ve diğer bazı kimyasal bileşenler nedeni ile yem olarak kullanılabilirliği araştırılmıştır. Limon kabuklarında bulunan protein miktarı (%9.42), yağ (%4.98), kül (%6.26), selüloz (%15.18), sodyum (755.5 mg/100g), potasyum (8600 mg/100g), kalsiyum (8452.5 mg/100g), bakır (4.94 mg/100g), demir (147.65 mg/100g), magnezyum (1429.50 mg/100g), çinko (13.94 mg/100g) ve fosfor (6656 mg/100g) İran ulusal hayvan yemi standardı ile karşılaştırılmıştır. Yağ, protein ve selüloz miktarlarının bu standardı karşılayabildiği görülmüştür.

Anahtar kelimeler: Limon kabuğu, hayvan yemi, AAS

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INTRODUCTION

Lemon (*Citrus limon*) is the third most important species of citrus after orange and mandarin, with a production totaling more than 4.4 million tones during the 2001/2002 season. Argentina with 1.2 million tones is currently the world's largest producer of lemons (1).

The peel is a by-product of lemon juice processing, with a high potential use. Two different tissues are found in what is colloquially called lemon peel, flavedo and albedo (2). Flavedo is the peel's outer layer, whose colour varies from green to yellow. It is a rich source of essential oils (3), which have been used since ancient times by the flavour and fragrance industry (4).

Albedo is the major component of lemon peel, and is a spongy and cellulosic layer laid under flavedo. The thickness of the albedo fluctuates according to several variables, among them variety and degree of ripeness. Albedo has high dietary fiber content, and if added to new meat products permits to formulate healthier products like beef burgers (5), bologna (6) and dry cured sausages (7). Furthermore, the presence of associated bioactive compounds (flavonoids and vitamin C) with antioxidant properties in fresh lemon albedo involves healthier benefits than other sources of dietary fiber (8).

In the present work, a low cost agricultural waste material, lemon peel has been used for a source of protein, fats, and essential macro minerals necessary for the growth of animals is being investigated.

MATERIALS AND METHODS

Reagents

All chemicals and solvents were of analytical-reagent grade and were used without further purification that supplied by Merck (Darmstadt, Germany). The water used was double distilled and purified using a Millipore system. Lemon peel samples were collected from the locals supermarkets (Khorasan, Iran). The obtained lemon peel was cut into small pieces using scissors. Then the lemon peels were dried at 100 °C for 24 h using hot air oven. After drying, samples were powdered with a mechanical grinder, packaged and stored in a refrigerator at 4 °C until required for use. Particle sizes after grinding were below 0.3 mm.

Apparatus

For metal determination, an Analytik Jena AG AAS ZEEnit 700P AAS (Jena, Germany) equipped with a flame and graphite furnace (GF) with the Zeeman background corrector was used in the experiments. WinAAS version 4.5.0 software was used. A Shimadzu UV-1700 Pharma spec. (Tokyo, Japan) was used for the determination of phosphorus.

Metal determination

The Na, K, Ca, Cu, Fe, Zn and Mg were determined by atomic absorption spectrophotometry. For digestion with wet ashing, 5 g lemon peel samples were used. Wet digestion of samples was performed by using mixtures of two acids, namely, HNO_3–HCl. Thirty mL of concentrated HNO_3 was used for a 5.0 g sample. Each mixture was heated on the hot plate. Gently boil unit 3-6 mL digest remains. Then, 25 mL concentrated HCl was added. Increase heat, and boil until 10-15 mL volume remains. After cooling, the residue was filtered through blue band filter paper. Then the sample was diluted to 50 mL with distilled water. The blank digestions were also carried out in the same way (9).

Physicochemical characteristics

The recommended methods of the Association of Official Analytical Chemists were employed in determining the levels of ash, crude protein, crude fat and fiber.

Ash was determined by the incineration of 2 g samples placed in a muffle furnace (LMF4 from Carbolite, Bamford, Sheffield UK) maintained at 550 °C for 5 hours. Crude protein (% total nitrogen x 6.25) was determined by Kjeldahl method (10), using 2 g samples; crude fat was obtained by exhaustively extracting 2 g of each sample in a Soxhelet apparatus using petroleum ether (boiling range 40-60 °C) as the extractant (11). Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (W/V) H_2SO_4 and 1.25% (W/V) NaOH solutions under specific conditions (12). Phosphorus was determined by spectrophotometer method based on Iranian national standard No. 513 (13). Phosphorous was determined as PO43- by the sodium phosphomolybdate in which the phosphorous present as the orthophosphate reacts with a sodium molybdate reagent to produce a yellow orange complex, the absorbance of which was measured at 420 nm. All results were expressed on a dry weight basis. Determinations were done in triplicates and results were expressed as averages on dry weight basis.

RESULTS AND DISCUSSION

Mineral Composition of lemon peel

The mineral content of lemon peel is shown in Table 1, levels of Na, K, Ca, Cu, Fe, Mg, Zn and P detected with value of 755.5, 8600, 8452.5, 4.94, 147.65, 1429.5, 13.94 and 6656 mg/100g. The concentrations are average values of four replicate measurements. Iron, copper, zinc and manganese play an important role in biological systems; they are essential for nutrition and are widely used in the fields of clinical medicine, environmental science and health (14-17). Thus, the analysis of these elements is clearly important.

K had the highest concentration (8600±0.028 mg/100g). K has been recognized as an essential nutrient in animal nutrition since its importance was pointed out by Sidney Ringer in 1883. K is essential for life. Young animals will fail to grow and will die within a few days when the diet is extremely deficient in K (18). The concentration of Ca in lemon peel samples is 8452.5±0.050 mg/100g. Ca is responsible for bone formation. Ca regulates many cellular processes and has important structural roles in living organisms (19).

Phosphorus is an essential nutrient for all animals too. Deficiency of Phosphorus is the most widespread of all the mineral deficiencies affecting livestock. Phosphorus must be balanced in the animal diet with adequate Ca and vitamin D for growth, reproduction, gestation, and lactation (20). Mg has been reported to be involved in maintaining the electrical potential in nerves and activation of some enzyme systems (21).

Physicochemical properties of lemon peel

Table 2 presents the physicochemical properties of lemon peel. From the data it was observed that the lemon peel contained crude fat (4.98%), crude fiber (15.18%) and protein (9.42%). Ash content of lemon peel in this study was 6.26%. Based on Iranian national standard ash content of maize, soybean oilcake and sunflower meal to be 1.5, 6 and 7%, respectively (22-24). Therefore with the value of ash reported in this study, lemon peel may be suitable for animal feeds.

The value of crude fat (4.98%), protein (9.42%) and fiber (15.18%) are comparable to the values for varieties of animal feed reported by Iranian national standard. The crude fat content was higher than those reported for maize, soybean oilcake and sunflower meal with value of 3.5, 0.5-2 and 2.5%, respectively (22-24). Fat promotes the absorption of fat soluble vitamins hence it is very important in diets (25). Fats contain the highest amounts of energy. In fact, fats contain

Table 1. Mineral composition (all the concentrations are shown in mg/100g)

Element	Lemon Peels (mean±SD)	LOD	LOQ
Sodium (Na)	755.50±0.058	0.22	0.83
Potassium (K)	8600.00±0.028	0.07	0.24
Calcium (Ca)	8452.50±0.050	0.08	0.32
Copper (Cu)	4.94±0.012	0.06	0.22
Iron (Fe)	147.65±0.068	0.14	0.54
Magnesium (Mg)	1429.50±0.008	0.13	0.59
Zinc (Zn)	13.94±0.007	0.04	0.15
Phosphorus (P)	6656.25±0.17	0.08	0.11

LOD: Limit Of Detection LOQ: Limit Of Quantification

Table 2 Physicochemical parameters of Lemon Peels

Parameter	Lemon Peels (% w/w)
Protein	9.42
Fiber	15.18
Ash	6.26
Fat	4.98

2.25 times more energy than carbohydrates. Fats play an important role in supplying the energy needed by an animal for normal body maintenance. Protein also plays a part in the organoleptic properties of foods in addition to being a source of amino acid.

Protein content of lemon peel in this study was 9.42%. Based on Iranian national standard ash content of maize, soybean oilcake and sunflower meal to be 8, 42-48 and 40%, respectively (22-24). Therefore with the value of Protein reported in this study, lemon peel may be suitable for animal feeds. Crude fiber helps in the maintenance of normal peristaltic movement of the intestinal tract hence diets containing low fiber could cause constipation and eventually lead to colon diseases (piles, cancer and appendicitis) (26). Fiber also plays an important role in ruminant digestion by increasing bacterial populations in the rumen. The crude fiber content was higher than those reported for maize, soybean oilcake and sunflower meal with value of 2.7, 3.3-7and 14%, respectively (22-24).

CONCLUSION

Minerals are important in the diet because they serve as cofactors for many physiologic and metabolic functions and in their absence, clinical deficiencies may occur. Both Ca and K were detected at significant levels. The levels of Na and K detected suggested that the lemon peel might prove useful in lowering elevated blood pressure. A significant level of Fe was also present in the lemon peel. Fe, Cu, Zn and Mg play an important role in biological systems; they are essential for nutrition and are widely used in the fields of clinical medicine, environmental science, medical jurisprudence and health (14-17). Thus, the analysis of these elements is clearly important.

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