NUTRITIONAL EVALUATION OF PULSE SPREADS IN COMPARISON TO NUTRIENT RECOMMENDATIONS

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Abstract

Non-dairy and reduced fat/calorie spreads are becoming important for health conscious people; as well as increasing consumer choice, animal product alternatives have the potential to contribute to overall public health. Pulses and pulse products are primarily popular among vegetarian and health conscious consumers and could benefit people struggling with dietary changes.

Therefore, the aim of this research was to analyse and collate nutritional values of four commercially available pulse (chickpeas or soy) spreads and one newly developed pulse (bean) spread in comparison to recommended daily allowance (RDA) of nutrients for adolescents and adults.

Bean spread was made of ground re-hydrated cooked seeds of beans, to which salt, spices and other ingredients were added. Macro-nutrients were determined according to standard methods. Nutritional values of commercially available pulse spreads were given according to product label information.

The results show that there are significant nutritional differences among the tested pulse spreads ($p<0.05$). A serving (100 g) of pulse spreads covers 5.2–9.8% protein, 3.8–32.2% fat, 1.5–3.8% carbohydrates and 3.4–14.0% energy of RDA for adolescents while 6.9–12.0% protein, 5.7–46.8% fat, 1.7–4.1% carbohydrates and 4.2–16.8% energy of RDA is covered for adults.

A serving of pulse spreads covers the least of RDA for male adolescents and the most for female adults out of the four groups. Even though pulses are considered a good source of B vitamins, pulse spreads are low in all but folic acid. Solely the new bean spread also contains significant amount of thiamine.

Keywords: pulse spreads, nutritional value, recommended daily allowance.

Introduction

Non-dairy and reduced fat/calorie spreads are becoming important for health conscious people who are seeking attractive products from different sources. As well as increasing consumer choice, animal product alternatives have the potential to contribute to overall public health. Pulses can serve as the base raw materials with added advantages of lower price of products and increased protein content (Veena, Bhattacharya, 2012). Pulse products are primarily popular among vegetarian and health conscious consumers and could benefit people struggling with dietary changes.

Pulses (grain legumes) are dry seeds of leguminous plants which are distinguished from leguminous oil seeds (soy, peanuts) by their low fat content. Pulses also exclude such leguminous vegetables as green peas and snap beans which are immature legume pods and green seeds (Codex Alimentarius Standart 171-1989, Rev. 1, 1995). This must be taken into account since the best known legume spread is peanut butter; pulse seeds, however, are made from dry and then re-hydrated edible variety of bean, pea and lentil seeds.

Pulses (family *Fabaceae*) have been consumed for at least 10 000 years and are among the most extensively used foods in the world. Nutritionally, they are characterised by high protein content (about 20–30%), a very high proportion of carbohydrate (about 50–65%) and a very low fat content (about 1%). They are a significant source of many nutrients, including fibre, protein and iron, as well as B group vitamins (Mudryj et al., 2012).

Pulses contain a mixture of soluble and insoluble fibre, which lowers total serum and low-density lipoprotein (LDL) cholesterol and aids in gastrointestinal function, respectively (Tosh, Yada, 2010); pulse consumption results in higher intakes of fibre, carbohydrate, protein, Ca, K, folate, Zn, Fe and Mg, with lower intakes of saturated as well as total fat (Mitchell et al., 2009). Pulses are also gluten-free, so products made from pulse flours provide alternatives to wheat flour based products (Siddiq et al., 2013).

However, their consumption in the Western world remains quite low at less than 3.5 kg per capita per year. In other parts of the world, annual pulse consumption can range from 10 kg per capita (South America and India) to 40 kg per capita (Burundi) (Mudryj et al., 2012). Among European countries, higher pulse consumption is observed around the Mediterranean, with per capita daily consumption between 8 and 23 g, while in Northern Europe, the daily consumption is less than 5 g per capita (Bouchenak, Lamri-Senhadji, 2013). In 2009, legume (including pulses, soy and nuts) consumption represented only 0.7% of total regularly consumed foods in Latvian food basket, with daily consumption 32±2 g per capita (Joffe et al., 2009). According to the Latvian Central Statistical Bureau (CSB) data, the average pulse consumption was 9 g per capita per day in 2013, with annual consumption 3.28 kg per capita.

Commercially available pulse spreads are a fairly new concept, while the main spread-like vegetable protein product humus can be described as ancient food. Today, humus, a Middle Eastern and Arabic food dip or spread made from cooked, mashed chickpeas blended with tahini, olive oil, lemon juice, salt and garlic, is popular throughout the Middle East, North Africa, Mediterranean and in Middle Eastern cuisine around the globe (Marks, 2010).

There are about 10 different plant-derived spreads commercially available in Latvia varying a lot in

nutritional value and ingredients. About half of them are oil, yeast or seed based and do not qualify as pulse (or legume) spreads. Latvian-produced spreads are more accessible to consumers in terms of price; however, they contain additives to ensure the texture or improve the structure of the product (thickeners, emulsifiers), improve the taste (flavour enhancing agents) and extend shelf life (preservatives).

The main difference in need for nutrients between adolescents and adults is higher total energy intake for adolescents because they experience greater increases in height, weight, and other aspects of body composition than adults; adolescent growth spurt is sensitive to energy and nutrient deprivation which can lead to delayed puberty or growth retardation (Stang, Story, 2005). Adolescents also need higher intakes of healthy fat which is necessary for brain and nerve cell development and growth (Nettleton et al., 2013).

In order to determine the need for nutritionally improved products, one needs to ascertain the existing products on the market. Therefore, the aim of this research was to analyse and collate nutritional values of four commercially available pulse (chickpeas or soy) spreads and one newly developed pulse (bean) spread in comparison to recommended daily allowance (RDA) of nutrients for adolescents and adults.

Materials and Methods

Pulse (bean) spread with sun-dried tomatoes was prepared at the laboratory of Faculty of Food Technology (Latvia University of Agriculture) according to the vegetarian spread preparation technology in RL patent Vegetarian bean spread production method application. Bean spread with sun-dried tomatoes was made of ground re-hydrated cooked seeds of white (navy) beans, to which salt, spices and other ingredients were added (Kirse et al., 2013).

Macro-nutrients were determined according to standard methods: protein content (AACC 46-20), fat content (AOAC 2003.06), total dietary fibre content (AOAC 994.13), ash content (ISO 2171:2010); available carbohydrates (g per 100 g of spreads) were determined by difference (Menezes et al., 2004) according to formula:

$$Available\ carbohydrates = 100 - (weight\ in\ grams\ [protein + fat + water + ash + dietary\ fibre]\ in\ 100\ g\ of\ food) \quad (1)$$

Nutritional values of commercially available pulse spreads are given according to product label information. Dietary fibre (for commercially available spreads) and vitamin content (mg or g per 100 g of spreads) was calculated according to formula:

$$\text{Vitamin or dietary fibre} = n \times \frac{a}{b} \quad (2),$$

where n – the amount of nutrient (vitamin or dietary fibre) in 100 g of cooked pulses/legumes, a – protein content in the given spread (per 100 g), b – protein content in the cooked pulse/legume (per 100 g).

USDA National Nutrient Database for Standard Reference was used for dietary fibre and vitamin content reference in cooked pulses.

The calculation of the amount of nutrients needed (recommended daily intake of nutrients expressed as recommended daily allowance) for adolescents and adults has been done based on the ordinance No 174 Recommended allowance of energy and nutrients for Latvian citizens, issued by Ministry of Health of the Republic of Latvia on October 15, 2008. Calculations were carried out in both groups per gender (female and male) and average values were used for further analysis.

The obtained data processing was performed using mathematical and statistical methods with statistical software *R 3.0.2*; differences among results were considered significant if p-value $<\alpha_{0.05}$. For the interpretation of the results it was assumed that α=0.05 with 95% confidence (Næs et al, 2011). Differences among nutritional value of different pulse spreads were analysed using one way analysis of variance and Tukey's test.

Results and Discussion

Five pulse spreads were compared in this study, four of which are commercially available: *ILO* Hummus by *Silva*, Finland (sample A), *Hum-Hum* Hummus by *Zila Laguna*, Latvia (sample B), *WD fit* soy spread by *W-D*, Poland (sample C), *BioGreno* Curry-Pineapple spread by *Bartels-Langness*, Germany (sample D) and bean spread with sun-dried tomatoes experimentally developed at the laboratory of Faculty of Food Technology in Latvia University of Agriculture, Latvia (sample E). General information about the investigated spreads is given in Table 1.

Table 1

Comparison of pulse spreads

Pulse spreads	Type of pulses used	Approximate shelf life	Price, EUR kg^{-1}
A	Chickpeas *Cicer arietinum* L.	8 weeks*	14.70
B	Chickpeas	4 weeks*	6.20
C	Soy *Glycine max* (L. Merr.)	4 weeks	8.00
D	Chickpeas and soy	8 months	13.80
E	Beans *Phaseolus vulgaris* L.	7 days	5.60**

* preservatives used

** price forecast

Data presented in Table 1 show that chickpeas and soy are the main legumes used in commercially available non-dairy spreads. As mentioned before chickpeas and soy are both legumes but belong to different subtypes of legumes, pulses and leguminous oil seeds, respectively. In this study soy spread has been included because soy is used for the content of protein not oil.

There are significant differences among the shelf life of these spreads, e.g. sample D has the longest shelf life

because curry-pineapple spread is filled in small glass bottles and heat treatment (pasteurisation) has been performed. Spreads A and B (hummus) have the shelf life up to two months because preservatives (sorbic acid E200, lactic acid E270, potassium sorbate E202) have been used. The shelf life of bean spread with sun-dried tomatoes is only one week because no heat treatment or preservatives were added and the proper packaging is currently being researched. The shelf life of bean spread with sun-dried tomatoes is equal to the expiration date of commercially available spreads when kept in the refrigerator after opened.

There are also significant differences among the price of the investigated spreads. The price of three spreads (B, C and E) is less than 10 EUR kg^{-1} and it is comparable to the price of dairy spreads. The ingredients of spread D have been grown in biological agriculture and this could be the reason for a higher price. The price of spread A could be higher because of increased marketing margin and raw materials of higher quality and price.

Nutritional value of pulse spreads is given in Table 2. Nutritional information of samples A-D is given according to product label information; protein, fat and carbohydrate content in bean spread with sun-dried tomatoes has been determined experimentally according to standard methods.

Table 2

Nutritional value of different pulse spreads, 100 g^{-1}

Pulse spreads	Protein, g	Fat, g	Carbohydrates, g	Energy, kcal
A	6.0[a]	10.0[a]	8.0[a]	146.0[a]
B	6.5[a]	29.0[b]	12.0[b]	335.0[b]
C	6.0[a]	22.2[c]	6.0[c]	247.8[c]
D	5.2[b]	4.3[d]	10.6[d]	101.9[d]
E	7.8[c]	8.3[e]	8.4[a]	139.5[a]

* values within a column not sharing a superscript letter are significantly different ($p<0.05$)

Spread E has the highest protein content out of all investigated spread samples ($p=0.012$). Commercially available non-dairy spreads contain significantly less protein and spread D has the least protein. Literature data confirm that white beans can contain significantly more protein than chickpeas and soy (Maskus, 2010).

Fat content in pulse spreads is significantly higher comparing with dry and cooked pulses ($p<0.001$) because of the oil added for a better texture. Spreads A, D and E have the least fat and they qualify as non-dairy, reduced fat spreads. Hummus produced in Latvia (spread B) already has the highest fat content, nevertheless, it is recommended to add more oil before eating it according to product label information.

Carbohydrates available for digestion by human enzymes account to less than 15 g 100 g^{-1} of pulse spreads; even though there are significant differences among five spread samples, pulse spreads are low in carbohydrates.

Bean spread with sun-dried tomatoes (spread E) contains 9.83±0.10 g 100 g^{-1} total dietary fibre; commercially available non-dairy spreads are not labelled as containing fibre.

According to Commission Directive 2008/100/EC and Regulation No 1924/2006, products can be labelled as a source of protein if at least 12% of the energy value of the food is provided by protein. Spreads A, D and E are a source of protein because 16%, 20% and 22% of the energy value is provided by protein, respectively. The same regulations allow labelling bean spread with sun-dried tomatoes (spread E) as high in fibre considering it contains ≥6.0 g fibre 100 g^{-1}.

A claim that a food is energy-reduced may be made if the energy value of the product is reduced by at least 30% with an indication of the characteristic(s) which make(s) the food reduced in its total energy value. Fat content is the characteristic which makes three spreads (A, D and E) energy-reduced as energy value of those spreads is 40.8% to 69.5% lower compared to spreads B and C.

The calculation of the amount of nutrients needed for adolescents and adults has been done based on the ordinance No 174 Recommended allowance of energy and nutrients for Latvian citizens, issued by Ministry of Health of the Republic of Latvia on October 15, 2008.

Reference values of recommended daily allowance (RDA) of nutrients are given in Table 3. The data have been used in subsequent calculations.

Table 3

Recommended daily energy and nutrient intake

Age group	Energy (E), kcal	Protein, E%	Fat, E%	Carbohyd-rates, E%
Adolescent				
– female	2400	10–15*	30–35*	50–55*
– male	3000			
Adult				
– female	2000	10–15*	25–30*	55–60*
– male	2400			

*average values were used for further calculations

Recommended daily energy intake for adolescent females and adult males is 10 042 kJ per day, while the amount is lower for adult females and higher for adolescent males, 8 368 kJ per day and 12 552 kJ per day, respectively. Adolescent males have higher caloric requirements since they experience greater increases in height, weight, and lean body mass than females. Protein needs for adolescents and adults are similar. (Stang, Story, 2005)

Recommended daily intake for fat of total energy intake is higher for adolescents. The human body requires dietary fat and essential fatty acids for normal growth and development; healthy fat (composed of mono- and polyunsaturated fatty acids) is necessary for brain and nerve cell development and growth, which is especially important for growing teens. Fat-soluble

vitamins A, D, E and K cannot function without adequate daily fat intake. (Nettleton et. al., 2013)
The calculation of the amount of nutrients needed for adolescents and adults was completed as the coverage of a nutrient by one serving (100 g) of pulse spreads in comparison to RDA.
The recommended daily intake of protein is 80 g for female adolescents, 100 g for male adolescents, 65 g for adult females and 75 g for adult males. A serving of pulse spreads covers 5.2–9.8% protein for adolescents and 6.9–12.0% protein for adults (Fig. 1).

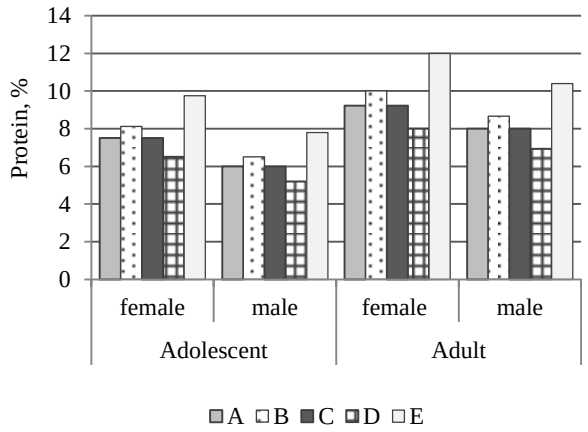


Figure 1. Protein coverage (%) of one serving of pulse spreads in comparison to RDA
A – *ILO* hummus, B – *Hum-Hum* hummus, C – *WD fit* soy spread, D – *BioGreno* Curry-Pineapple spread, E – bean spread with sun-dried tomatoes

As spread E has the highest protein content, protein coverage of bean spread with sun-dried tomatoes is the best. Spread E can be considered a good source of protein for adults. Protein coverage for adolescent males is the lowest because the requirements for protein in this group are the highest.

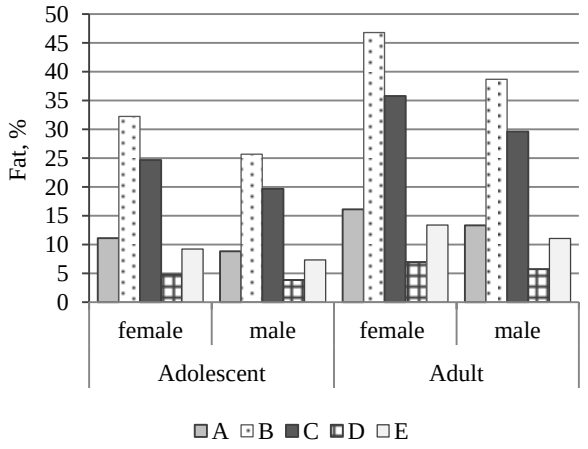


Figure 2. Fat coverage (%) of one serving of pulse spreads in comparison to RDA
A – *ILO* hummus, B – *Hum-Hum* hummus, C – *WD fit* soy spread, D – *BioGreno* Curry-Pineapple spread, E – bean spread with sun-dried tomatoes

The recommended daily intake of fat is 90 g for female adolescents, 113 g for male adolescents, 62 g for adult females and 75 g for adult males. A serving of pulse spreads covers 3.8–32.2% fat for adolescents and 5.7–46.8% fat for adults (Fig. 2). There are significant differences among the coverage of fat in the four groups ($p<0.05$).
Spreads B and C cover the most of fat compared to the other three spreads. Hummus produced in Latvia (spread B) covers almost half of recommended daily intake for adult females.
Contrary to protein, fat coverage as high from one serving cannot be considered a good indicator. A serving of spreads B or C cannot be recommended for daily consumption. Fat coverage for adolescent males is the lowest once more because the requirements for fat in this group are the highest.
The recommended daily intake of carbohydrates is 320 g for female adolescents, 400 g for male adolescents, 295 g for adult females and 355 g for adult males.
A serving of pulse spreads covers 1.5–3.8% carbohydrates for adolescents and 1.7–4.1% carbohydrates for adults (Fig. 3).

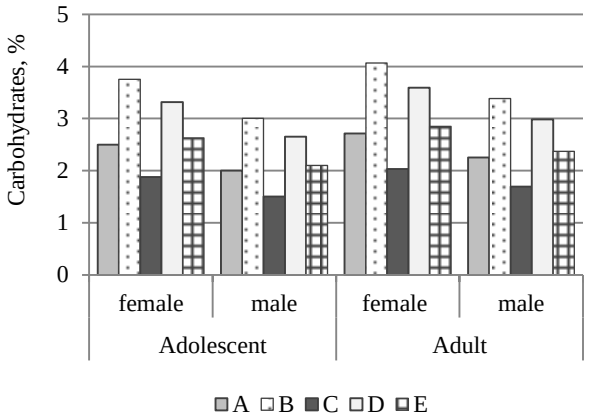


Figure 3. Carbohydrate coverage (%) of one serving of pulse spreads in comparison to RDA
A – *ILO* hummus, B – *Hum-Hum* hummus, C – *WD fit* soy spread, D – *BioGreno* Curry-Pineapple spread, E – bean spread with sun-dried tomatoes

Compared to RDA, carbohydrate coverage is low for all investigated pulse spreads.
As mentioned before, commercially available non-dairy spreads are not labelled as containing fibre, however, after calculations it can be concluded that dietary fibre content in spreads A-C is around 5.2 g 100 g^{-1} and spread D contains at least 4.0 g 100 g^{-1} dietary fibre. Bean spread with sun-dried tomatoes (spread E) contains more total dietary fibre (9.83±0.10 g 100 g^{-1}) than other pulse spreads ($p=0.009$).
According to European Guidelines on cardiovascular disease prevention recommended dietary fibre intake is 30–45 g per day or 3.4 g per 1000 kJ (Perk et al., 2012). While *Guideline Daily Amounts (GDA) Labelling Initiative* (by The Confederation of the Food and Drink Industries of the EU) recommends 25 g

dietary fibre per day for both genders (reference amount for 2000 kcal diet) but no further recommendations for diets in lower or higher calories are given.

Therefore, if European Guidelines on cardiovascular disease prevention are used as reference for optimal dietary fibre intake, a serving of pulse spreads covers 12–21% fibre for adolescent males, 15–26% fibre for adolescent females and adult males and 18–31% fibre for adult females.

A serving of pulse spreads covers 3.4–14.0% energy for adolescents and 4.2–16.8% energy for adults (Fig. 4).

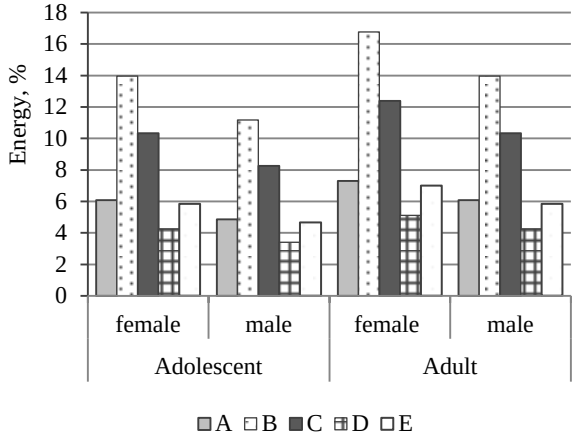
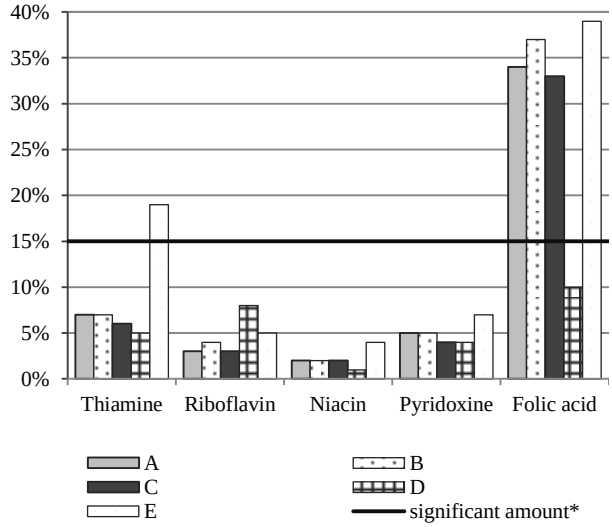


Figure 4. Energy coverage (%) of one serving of pulse spreads in comparison to RDA

A – *ILO* hummus, B – *Hum-Hum* hummus, C – *WD fit* soy spread, D – *BioGreno* Curry-Pineapple spread, E – bean spread with sun-dried tomatoes



*15% of RDA

Figure 5. Vitamin coverage (%) of one serving of pulse spreads in comparison to RDA

A – *ILO* hummus, B – *Hum-Hum* hummus, C – *WD fit* soy spread, D – *BioGreno* Curry-Pineapple spread, E – bean spread with sun-dried tomatoes

Spreads B and C cover as much as twice the amount of calories per one serving of other pulse spreads; most of the calories come from fat. As mentioned before spreads A, D and E are energy-reduced and can be considered a good source of macronutrients for daily consumption.

Pulses are a good source of B vitamins, namely B_1, B_2, niacin, pyridoxine and folic acid (Ofuya et al., 2005); however, pulse spreads are low in most of them (Fig. 5). According to Regulation No 1924/2006 a claim that a food is a *source of vitamins* can be made if the product contains at least a significant amount, i.e., 15% of the recommended daily allowance (which in absolute numbers is equal for adolescents and adults).

All pulse spreads except spread D are a source of folic acid because soy has lower amounts of the vitamin previously classified as B_9. Solely bean spread with sun-dried tomatoes also contains significant amount of thiamine (p=0.008).

Conclusions

A serving of pulse spreads (including soy spread) covers the least of RDA for male adolescents and the most for female adults out of the four groups.

Even though pulses are considered a good source of B vitamins, pulse spreads are low in all but folic acid. Solely the new bean spread also contains significant amount of thiamine.

Nutritional value of pulse spreads is essentially different, depending on the raw materials used for spread production.

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