MACROJOURNALS

The Journal of **Macro**Trends in Applied Science

Mineral and polyphenol contents of self-brewed and commercial beer samples

Edina Szabó–Péter Sipos
Faculty of Agricultural and Food Sciences and Environmental Management
University of Debrecen, Hungary

Abstract

Beer is one of the world's oldest drinks, which is an excellent source of minerals and polyphenols. The mineral and total polyphenol contents of self-brewed and commercial beers were determined and compared with the Recommended Dietary Allowance (RDA) values.We tried to find out during our research whether the self-brewed or the commercial beers can contribute better to our daily needs. We established that the brewed beers usually had higher polyphenol contents and contained more minerals than the commercial beers. So we proved that the self-brewed beers can contribute better to our health than the commercial beers.

Keywords: *mineral, polyphenol, beer*

1. Introduction

Beer is easily digestible and one of the most popular beverages, which is as old as our civilization (Kalušević et al., 2011; Dostalek et al., 2006; Buiatti, 2009). It had especially important role in the past when the purity of water was uncertain, and it was used even for medication. Because it was not only drink, but it contains more materials that are associated with positive impacts on the body (some vitamins, fibre, as well as relatively low levels of ethanol, certain minerals, and antioxidants) (Bamforth, 2002; Eßlinger, 2009; Cortacero-Ramírez et al., 2003; Buiatti, 2009; Jaskura-Goiris et al., 2010; Kabelová et al., 2008).

The brewing was common in the past, so the methods and recipes have been improved over time (Eßlinger, 2009; Iimure-Sato, 2012). Nowadays we produce beer from barley malt, hops, and additives such as yeast (Iimure-Sato, 2012). Thanks to these raw materials, beer is rich in vitamins, proteins, organic acids, minerals and polyphenols (Kalušević et al., 2011; Hofta et al., 2007; Gerhäuser, 2005).

Polyphenols originate mainly from the hops, but the main sources of the minerals in beer are cereals, water, hops and additives, the yeast and the processing contribute to a less (Kalušević et al., 2011; Gerhäuser 2005; Montanari et al., 2009). The most of the minerals (about 75%) originates and derives from the barley malt, while the remaining 25% originates from the water. The mineral composition of the malt is determined by the variety, the place where it was grown, atmospheric condition, growing techniques, harvesting, storage, and malting system. The mineral content, the quality and the flavor of brewing water influence the quality and flavor of the final beer. Because hops are added in fewer amount during the brewing, it contributes a negligible amount of the minerals in beer. However raw materials contain a large amounts of minerals, but the levels of them decrease during the brewing process, and some minerals are removed through precipitations (Montanari et al., 2009).

The principal macroelements of beer are potassium (K), phosphorus (P), magnesium (Mg), sodium (Na), calcium (Ca), the minor elements are zinc (Zn), iron (Fe), and copper (Cu).

K contributes to the salty flavour of beer, but it is important to the yeast growth, to the metabolism of carbohydrates and for all enzymatic reactions which proceed with ATP. Na originated from the water and malt, and influences the flavor of beer, enhances its sweetness (Montanari et al., 2009). Beer contains relatively high level of K and low level of Na, because of this it could be an ideal drink for hypertensive patients (Stefano-Montanari, 1996). The relatively high K to Na ratio (typically 4:1) is consistent with a low Na diet. Related to this, beer has a significantly greater diuretic effect than water (Buday-Denis, 1974).

Ca comes from brewing water, and influences the pH, β-amylase, flocculation of yeast (Montanari et al., 2009). It is very important to the human healthy teeth, and bones (I1). Mg is very important not only for the yeast but also for the enzimatic processes of the human body (Montanari et al., 2009; I2). Because of its Ca and high Mg content beer can contribute to the protection against gall stone and kidney stone. These minerals are not only important to our health, but also contribute to the flavor (sweet, salty, bitter, and sour), so quality of the beer (Schoenberger et al. 2002; Montanari et al., 2009).

Zn and P influence the protein synthesis of human body and yeast cell, the yeast cell growth, and the fermentation (Montanari et al., 2009; I3).

Fe, Mo, Cu are very important for the human body in a little amount. Fe takes a share in the transports of O_2 and CO_2, Mo influences the degradation of nucleic acids, and aminoacids, Cu helps the infiltrate of Fe to the hemoglobin (I4; I5; I6).

Polyphenols are the other important compounds of the beer, and their determination is very useful to control the production, it is a perfect indicator of the status of fermentation and ageing and they influence its colloidal stability, savour, moderate the bitterness, aging and colour (Peris et al, 1991).

Our aims were to deteremine the mineral compounds and the total polyphenol contents of self-brewed and commercial beers, and to compare the results with the Recommended Dietary Allowance (RDA) values. We would like to establish which beer can contribute better to our health.

2. Method

In our researches the mineral and the total polyphenol content of our self-brewed, unfiltered beers and commercial beers were determined. Our self-brewed beers were produced by Zip's Micro Brewery Equipment in the laboratory of the Institute of Food Science at the University of Debrecen, using the recipe of the equipment. Slovak Pilsner malt and different caramel malts were used for all beers. Colouring malt was added to get the expected dark colour of the brown beers. We used different bitter and aroma hops to determine which and how influences the mineral and the total polyphenol contents.

Tap water was used for samples 1-5, for the light beer from stream water was taken from Kecső stream in Slovakia, and for the last the source of water was the deep-fount of a mineral water company, Debrecen. We produced ale and lager beers, too. Samples were taken from one brewing process, chemical analysis were performed in triplicate. The components of the self-brewed beers are shown in *Table 1.*

Table 1. The components of self-brewed beers

	Water			Malts			Hops		Yeast	
	tap	stream	mineral	Malt	caramel malt	colouring malt	bitter hops	aroma hops	lager	ale
Brown beer 1.	47 l	-	-	6 kg Slovak Pilsner[1]	0,5 kg Cara-Hell[1]	0,3 kg Carafa Type 1[2]	15 g Aurora[2]	30 g Spalt Select[3]	11,5 g Saflager[4]	-
Brown beer 2.	39 l	-	-	6 kg Slovak Pilsner[1]	0,5 kg Carabelge[2]	0,3 kg Carafa Type 1[2]	15 g Aurora[2]	30 g Spalt Select[3]	12 g Brewferm lager[5]	-
Light beer 1.	42 l	-	-	5 kg Slovak Pilsner[1]	0,5 kg Cara-Hell[1]	-	8 g Aurora[2]	16 g Spalt Select[3]	-	11, 5 g Safbrew T-58[4]
Light beer 2.	42 l	-	-	5 kg Slovak Pilsner[1]	0,5 kg Cara-Hell[1]	-	8 g Aurora[2]	16 g Spalt Select[3]	-	11, 5 g Safbrew T-58[4]
Light beer 3.	42 l	-	-	5 kg Slovak Pilsner[1]	0,5 kg Carabelge[2]	-	8 g Aurora[2]	16 g Spalt Select[3]	12 g Brewferm lager[5]	-
Light beer from stream water	-	42 l	-	5 kg Slovak Pilsner[1]	0,5 kg Carabelge[2]	-	8 g Spalt Select[3]	16 g Saphir[2]	12 g Brewferm lager[5]	-
Light beer from mineral water	-	-	42 l	5 kg Slovak Pilsner[1]	0,5 kg Carabelge[2]	-	8 g Spalt Select[3]	16 g Saphir[2]	12 g Brewferm lager[5]	-

Distributor: [1]Weyermann-Deutschland, [2]No dates, [3]Hallertauer-Deutschland, [4]Fermentis, [5]Brouwland

Commercial beers were bought from local supermarkets in Debrecen, Hungary and Oradea, Romania. We analysed these commercial beers (*Table 2*.):

Table 2. The evaluated commercial beer samples

	Commercial beer samples			
1	Bought in Debrecen, Hungary	Borsodi	light beer	
2		Becks	light beer	
3		Carlsberg	light beer	
4		Heineken	light beer	
5		Holsten	light beer	
6		Kanizsai	light beer	
7		Löwenbrau	light beer	
8		Pilsner Urquell	light beer	
9		Soproni	light beer	
10		Soproni Virgin	light beer	alcohol free
11		Soproni Fek démon	brown beer	
12		Guiness Draught	brown beer	
13	Bought in Oradea, Romania	Becks	light beer	
14		Carlsberg	light beer	
15		Holsten	light beer	

We determined the mineral and the total polyphenol contents of commercial light, light and alcohol free and brown beers, too.

Mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), total polyphenols were quantified by Folin-Ciocalteu colorimetric method (760 nm), results were given in gallic-acid equivalent value (Kalušević et al., 2011). Data were subjected to variance analysis (p=0,05).

3. Result and discussion

3.1. Polyphenols in beers

The total polyphenol contents of the produced and commercial beers are represented in *Figure 1.* Brown beer 1 contained the highest amount of polyphenols, while the light beer 2 and the light beer brewed with mineral water were the poorest in antioxidants, they contained significantly few polyphenols like the other beers. Carlsberg from Romania contained

significantly more polyphenol components than the other commercial beers, Kanizsai was the poorest in this polyphenols.

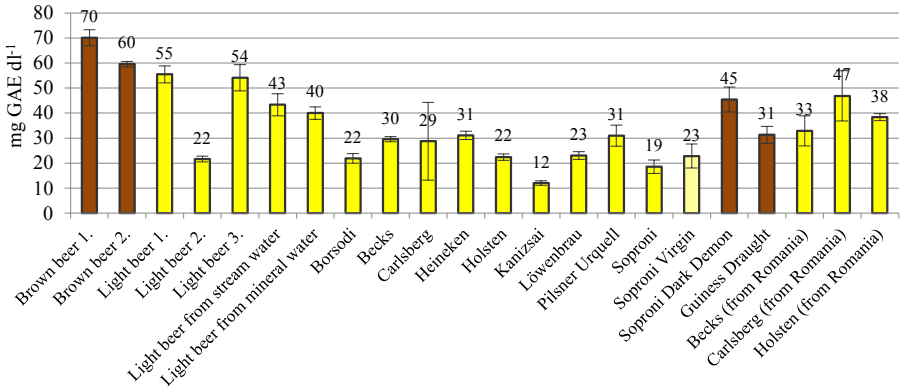

Figure 1. The total polyphenol contents of self-brewed and commercial beers

3.2. Macroelements in beers

Beers contained a lot of macroelements, but K had the highest level in beers. There were P, Mg, Na, Ca in beer samples, too. Brown beer 1 contained significantly more K, Kanizsai contained the fewest K. There was a lot of P in the beer samples. A lot of P was in Holsten from the commercial beers, the fewest P was in Kanizsai. We found the most Mg in Brown beer 1, but Kanizsai contained significantly fewer Mg than the other beer samples. There was significantly more Na in Holsten beer, the fewest in the Kanizsai. Soproni Dark Demon contained the most Ca, but the fewest Ca was in the light beer 1. So we could establish, that the brown beer 1, and Holsten were the richest in macrominerals, but the Kanizsai was the poorest in macroelements. We could see this on the *Figure 2.*

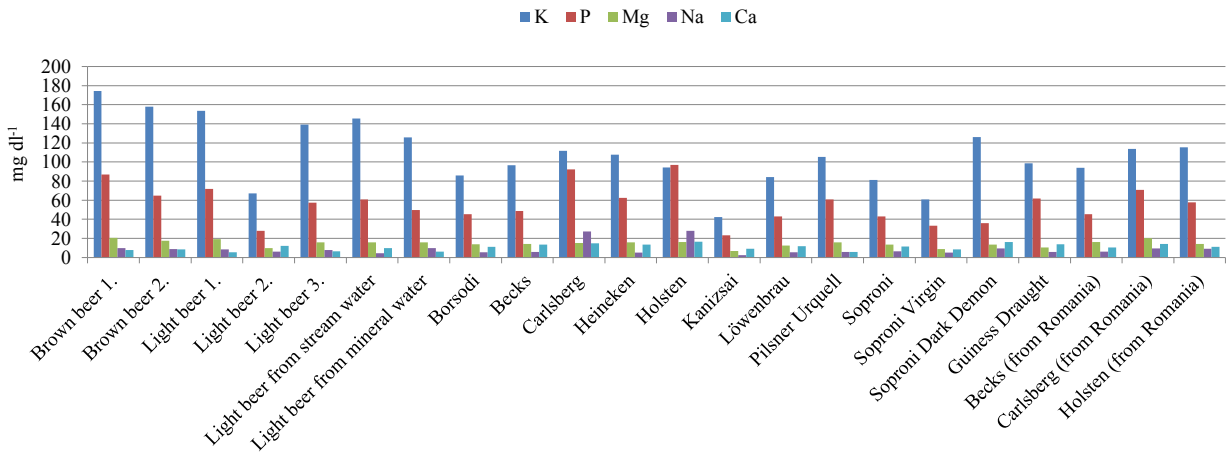

Figure 2. Macroelement contents of the self-brewed and the commercial beers

3.3. Microelements in beers

We measured the level of Zn, Fe, Mo and Cu in beers (*Figure 3*.). Zn was in the highest amount in beers, but there were two exceptions, because brown beer 1 contained the more Fe, Guiness Draught more Mo. The level of Zn was significantly higher in Heineken, but the lowest in Carlsberg. The most Fe was in brown beer 1, the fewest in Holsten. Guiness Draught contained the most of Mo, but light beer from mineral water didn't contain Mo. Brown beer 1., Borsodi, Heineken, Löwenbrau, Pilsner Urquell, Soproni, Guiness Draught, and the roman Beck's, Carlsberg and Holsten contained similar amount of Cu, but the light beer from mineral water had the lowest level of Cu.

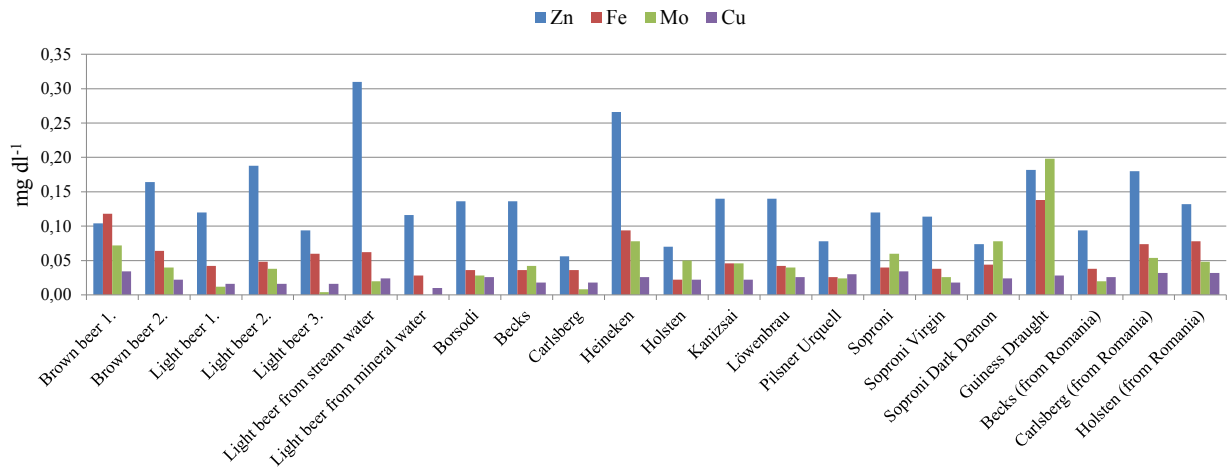

Figure 3. Microelement contents of the self-brewed and the commercial beers

We measured Li, Al, Sr, B and Ba (*Figure 4.)* in beers, too. There was a lot of Li in beer samples. We measured Al, Sr, B, and Ba in a little amount. The significantly high level of Li was in Heineken, the fewest in light beer from mineral water. We found a lot of Al in Kanizsai, the fewest Al was in light beer 1. The roman Carlsberg contained the most Sr, but Pilsner Urquell and Soproni Virgin had similar low Sr contain. We could measure a few B and Ba in beer samples. Pilsner Urquell contained the fewest, the roman Carlsberg the most B. The level of Ba was the highest in Guniess Draught, the lowest in Soproni Virgin. On the whole we could establish that the self-brewed and commercial beers were not so different in the contents of these elements.

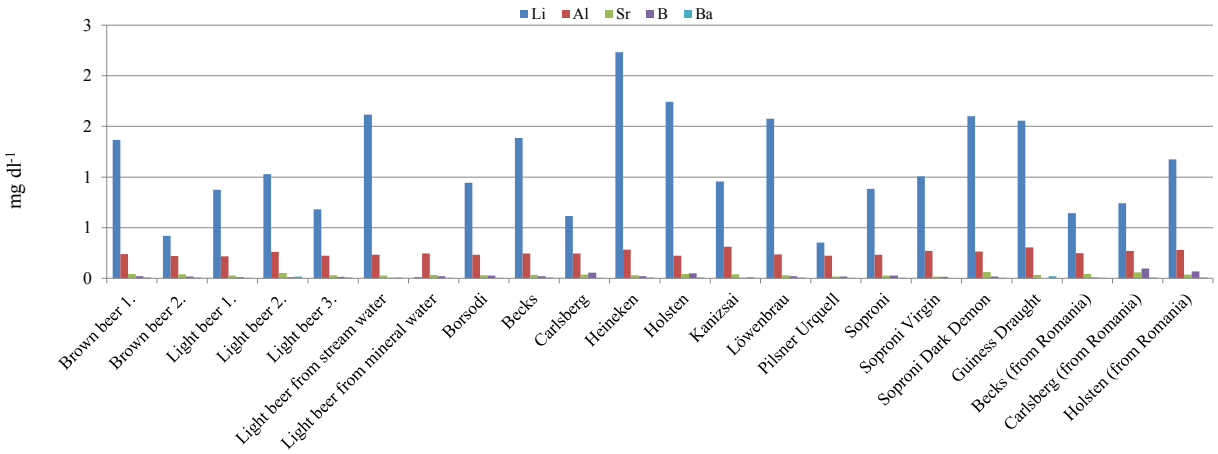

Figure 4. Measured other minerals

4. Conclusion

We established that the self-brewed beers contained more polyphenols than the commercial beers. But the Soproni Dark Demon and Carlsberg from Romania had as high polyphenol contents as the brewed beers. The brown beers contained more polyphenols than the light beers.

The levels of K, P, Mg and Na were usually higher in the self-brewed beers than in the commercial beers, but the Ca content was higher in the commercial beers than in the self-brewed beers. We measures Zn, Fe, Mo and Cu in beers. In the amount of microelement contents were not so high differencies in the self-brewed and in the commercial beers.

Table 3. The comparison of the result with the RDA

	How much percentages of the Recommended Dietary Allowance?								
	K	P	Mg	Na	Ca	Zn	Fe	Mo	Cu
Daily needs (mg)	***3500***	***800***	***300***	***2000***	***800***	***15***	***14***	***0,25***	***1,4***
Brown beer 1.	4,98	10,85	6,89	0,50	0,96	0,69	0,84	**28,80**	2,43
Brown beer 2.	4,51	8,11	5,82	0,45	1,05	1,09	0,46	**16,00**	1,57
Light beer 1.	4,39	**8,98**	6,45	0,42	0,67	0,80	0,30	4,80	1,14
Light beer 2.	1,92	3,47	3,25	0,31	1,51	1,25	0,34	**15,20**	1,14
Light beer 3.	3,98	**7,19**	5,25	0,40	0,79	0,63	0,43	1,60	1,14
Light beer from stream water	4,16	7,59	5,24	0,22	1,25	2,07	0,44	**8,00**	1,71
Light beer from mineral water	3,60	**6,22**	5,26	0,48	0,77	0,77	0,20	0,00	0,71
Borsodi	2,46	5,68	4,57	0,28	1,37	0,91	0,26	**11,20**	1,86
Becks	2,76	6,09	4,77	0,29	1,69	0,91	0,26	**16,80**	1,29
Carlsberg	3,20	**11,55**	5,10	1,36	1,86	0,37	0,26	3,20	1,29
Heineken	3,08	7,80	5,28	0,26	1,68	1,77	0,67	**31,20**	1,86
Holsten	2,70	12,13	5,41	1,40	2,08	0,47	0,16	**20,00**	1,57
Kanizsai	1,21	2,89	2,24	0,12	1,14	0,93	0,33	**18,40**	1,57
Löwenbrau	2,41	5,38	4,15	0,28	1,47	0,93	0,30	**16,00**	1,86
Pilsner Urquell	3,01	7,58	5,31	0,30	0,71	0,52	0,19	**9,60**	2,14
Soproni	2,32	5,37	4,51	0,33	1,43	0,80	0,29	**24,00**	2,43
Soproni Virgin	1,73	4,17	2,95	0,26	1,08	0,76	0,27	**10,40**	1,29
Soproni Dark Demon	3,60	4,48	4,54	0,47	2,03	0,49	0,31	**31,20**	1,71
Guiness Draught	2,82	7,72	3,49	0,29	1,74	1,21	0,99	**79,20**	2,00
Becks (from Romania)	2,68	5,68	5,37	0,30	1,32	0,63	0,27	**8,00**	1,86
Carlsberg (from Romania)	3,24	8,86	6,73	0,47	1,77	1,20	0,53	**21,60**	2,29
Holsten (from Romania)	3,30	7,22	4,77	0,46	1,40	0,88	0,56	**19,20**	2,29

Resources: I7, I8

When we compared the mineral contents of beers with the RDA, and we determined in percentages, that the mineral contents of beers are how much percentages of the RDA we established that the beer can contribute to our Mo daily needs at most. The light beer 1, light beer 3, light beer from mineral water, and the Carlsberg can contribute better to our P daily needs. *Table 3*. To summary we could confirm that beer is not only fine but also valuable beverages and it can contribute (assuming moderate consumption) to maintain our health.

References

Bamforth C. W.: 2002. Nutritional aspects of beer—a review. *Nutrition Research 22.* 227–237p

Biuatti S.: 2009. Beer Composition: An overview. (in) Beer in health and disease prevention. (ed) Preedy V. R. 213- 226p

Buday A. Z. - Denis G.: 1974. The diuretic effect of beer. *Brew Dig. 49(6).* 56–8p

Cortacero-Ramírez S.; Hernáinz-Bermúdez de Castro M.; Segura-Carretero A.; Cruces-Blanco C.; Fernández-Gutiérrez A.: 2003. Analysis of beer components by capillary electrophoretic methods. *Trends in Analytical Chemistry Vol. 22,* Nos. 7+8, 440-455p

Dostalek P.; Hochel I.; Mendez E.; Hernando A.; Gabrovska D.: 2006. Immunochemical determination of gluten in malts and beers. *Food Additives and Contaminants 23.* 1074-1078p

Eßlinger H. M. (ed): 2009. Handbook of Brewing. Processes, Technology, Markets. Wiley-VCH, 778p

Gerhäuser C.: 2005. Beer constituents as potential cancer chemopreventive agents. *European Journal of Cancer 41*. 1941-1954p

Hofta P.; Dostalek P.; Sykora D.: 2007. Liquid chromatography-diode array and electrospray high-accuracy mass spectrometry of iso-α-acids in DCHA-Iso-standard and beer. *Journal of the Institute of Brweing 113*. 48-54p

Iimure T. – Sato K.: 2012. Beer proteomics analysis for beer quality control and malting barley breeding. *Food Research International*. 1-8p

Jaskura-Goiris B.; Aerts G.; De Cooman L.: 2010. Hop α-acids isomerisation and utilisation: an experimental review. *Cerevisia 35*. 57-70p

Kabelová I.; Dvoraková M.; Cizková H.; Dostálek K.; Melzoch K.: 2008. Determination of free amino acids in beers: A Comparison of Czech and foreign brands. *Journal of Food Composition and Analysis 21*. 736-741p

Kalušević A.; Uzelac G.; Veljović M.; Despotović S.; Milutinović M.; Leskošek-Čukalović I.; Nedović V. (ed): 2011. The antioxidant properties of honey beer, in Food Process Engineering a Changing World, Proceedings of the 11th International Congress on Engineering and Food (ICEF11) VOLUME III, Greece. 2057-2058p

Montanari L.; Mayer H.; Marconi O; Fantozzi P.: 2009. Minerals in beer. (in) Beer in health and disease prevention. (ed) Preedy V. R. 359-365p

Peris M.; Müller D.; Maquieira A.: 1991. Determination of Total Polyphenols in Beers by Flow Injection Analysis, *Food Chemistry 40*, 1-8p

Schoenberger C.; Krottenthaler M.; Back W.: 2002. *M BAA Tech. Q. 39* . 210 ‑ 217p

Stefano A. - Montanari L.: 1996. *Alcologia 8*. 43 ‑ 45p

Internet:

I1: http://www.vitaminok.info/kalcium
I2: http://www.vital.hu/themes/health/magnesium1.htm
I3: http://www.vitaminok.info/foszfor
I4: http://www.vitaminok.info/vas
I5: http://www.vitaminok.info/molibden
I6: http://www.vitaminok.info/rez
I7: http://www.vitaminlexikon.hu/javasolt-napi-vitaminbevitel-rda/
I8: http://bertengo.com/kalkulatorok/vitaminkalkulator/