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SENSORY AND CHEMICAL ASPECTS OF ASTRINGENCY OF POLYPHENOLIC COMPOUNDS FROM LEGUME SEEDS

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Sensory and "chemical" astringency of extracts of phenolic compounds obtained from seven varieties of legumes were determined in the study. The astringency of extracts determined with the method of sensory scaling was found to be as follows: red bean > Adzuki bean > red lentil > green lentil > pea > broad bean > faba bean, whereas that determined spectrophotometrically was as follows: green lentil > red lentil > red bean > Adzuki bean > pea > broad bean > faba bean. A statistically significant correlation ($r = 0.77$; $p \leq 0.05$) was found between the "chemical" and sensory astringency.

INTRODUCTION

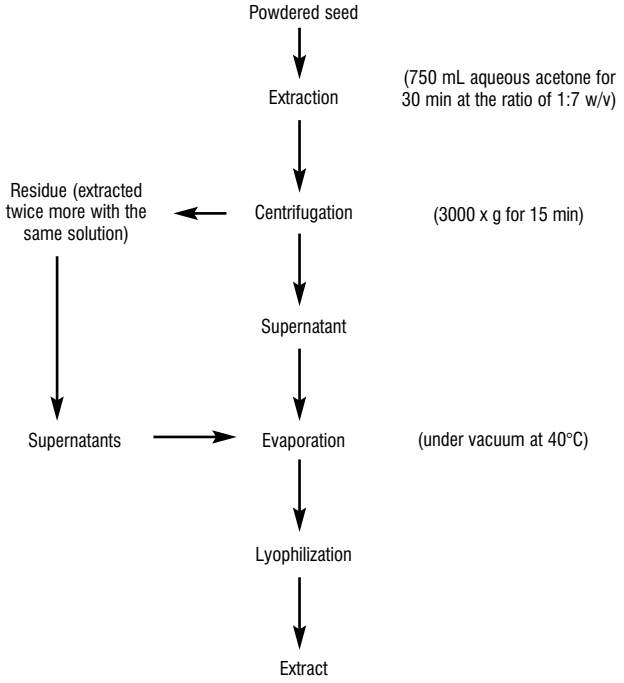
Polyphenolic compounds (tannins) have been considered a health-promoting component in plant-derived foods and beverages. For example, tannins have been shown to have anticarcinogenic and antimutagenic potential, possibly due to their antioxidant activities, and to have antimicrobial properties [Harbone & Williams, 2000; Chung *et al.*, 1998; Katiyar & Mukhtar, 1996]. On the other hand, consumption of tannin-rich food and beverages is associated with the sensation described as astringency. Chemically – astringents are defined as compounds which precipitate proteins [Bate-Smith, 1954], whereas sensorically – astringency is perceived as a dry or rough sensation felt in the mouth [Noble, 1989].

The objective of the study was to determine the astringency of polyphenolic compounds extracted from legume seeds as well as to touch upon relation between their astringency evaluated by sensory analysis or estimated with chemical assay.

MATERIAL AND METHODS

Material. The experimental material consisted of the following legume seeds: faba bean (*Vicia faba var. minor*), broad bean (*Vicia faba var. major Harz*), Adzuki and red bean (*Phaseololus vulgaris* L), pea (*Pisum sativum* L) as well as green and red lentil (*Lens culinaris*). The varieties of seeds specified above were used to obtain extracts of phenolic compounds (Scheme 1), which were then assayed for astringency with chemical and sensory analyses.

Chemical analyses. Total phenolics in the extracts were determined with the colorimetric method with



SCHEME 1. Obtaining extracts of phenolic compounds from legume seeds.

Folin-Ciocalteau reagent [Julkunen-Tiitto, 1985]. "Chemical" astringency of the extracts was assayed with the spectrophotometric method [Makkar *et al.*, 1988] (Scheme 2). Results were given as absorbance values per gram of extract (A_{510}/g).

Sensory analyses. A panel consisting of six female and three male students (from the University of Warmia and Mazury in Olsztyn), and staff of the Institute of Animal Reproduction and Food Research of the Polish Academy of

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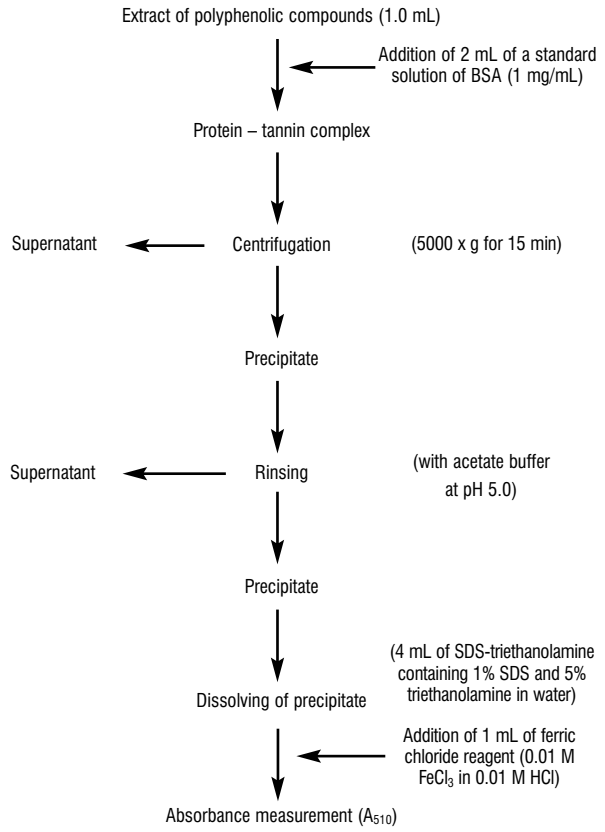

SCHEME 2. Determination of extract astringency with spectrophotometric method.

Sciences, Olsztyn. They all were familiarised with the method of sensory scaling of astringency during a 2-week training (nine sessions).

The intensity of astringency sensation of the extracts was determined by the method of sensory scaling [ISO 4121:1987]. Unstructured 10-unit linear scale anchored "none-very intensive" was used. The samples were individually coded and presented in random order to the panellists. The assessments were made in a sensory laboratory room, following general requirements for sensory testing conditions [ISO 8589:1998]. A computerised system was used for experimental setting and data collection.

Sensation of Astringency Indices (SAI) were calculated according to the method described by Matuszewska *et al.* [2000].

Statistical analysis. Correlation analysis between Sensation of Astringency Indices (SAI) and the content of either total phenols or "chemical" astringency (A_{510}) in the samples was performed using Microsoft Excel software (Microsoft 1997).

RESULTS AND DISCUSSION

Extraction of phenolic compounds from the investigated species of legumes was performed with a 75% aqueous acetone (Scheme 1). That solvent was selected for the experiment on the basis of literature data [Amarowicz *et al.*, 1995], which indicate that acetone is able to extract much more phenolic compounds from legume seeds than water, ethanol or methanol. A comparative anlaysis of extraction

TABLE 1. Total phenolic compounds in extracts; their "chemical" astringency and extraction efficiency.

Extract	Total phenolic compounds*[mg/g]	Astringency [A_{510}/g]	Extraction efficiency [g/100 g]
Faba bean	33.2 ± 0.63	9.6 ± 0.35	5.09
Broad bean	8 ± 1.13	13.3 ± 0.77	4.49
Adzuki bean	291 ± 0.98	38.1 ± 0.70	5.70
Red bean	56 ± 0.70	44.4 ± 0.42	5.18
Pea	24.5 ± 0.91	21.5 ± 1.20	5.20
Red lentil	62 ± 0.56	49.6 ± 0.98	4.46
Green lentil	73 ± 0.98	51.1 ± 0.49	4.70

*expressed as D (±) equivalent of catechin

efficiencies indicates that they were similar for all the seeds under study (Table 1) and fluctuated from 4.46 g/100 g (red lentil) to 5.70 g/100 g (Adzuki bean).

The results of the contents of phenolic compounds as well as "chemical" astringency of extracts from: faba bean, broad bean, Adzuki and red bean, pea, red and green lentil, were presented in Table 1. Determination of "chemical" astringency of extracts was presented in Scheme 2. The total phenolic compounds, expressed in catechin equivalents (±), was shown to be diversified and ranged from 24.50 mg/g of extract (pea) to 91.24 mg/g of extract (red bean). The extracts were characterised also by different "chemical" astringency expressed in absorbance values (A_{510}) per gram of extract. The highest absorbance value was reported for green bean (51.14 A_{510}/g), while the lowest one - for faba bean (9.65 A_{510}/g). On the basis of results obtained, the "chemical" astringency of the extracts can be ordered as follows: green lentil > red lentil > red bean > Adzuki bean > pea > broad bean > faba bean. The extracts with the lowest astringency (pea, broad bean, faba bean) were at the same time characterised with the lowest content of phenolic compounds.

In order to compare the results of chemical and sensory analyses of astringency, Sensation of Astringency Indices (SAI) were calculated for particular extracts. Exemplary mean results of astringency sensation intensity of the extracts determined with the sensory scaling method as well as the manner of SAI calculation were presented in Figure 1. The indices (SAI) were developed as a ratio of half scale astringency intensity (5 units) evoking its extract concentration. The SAI values for the extracts as well as concentrations of the extracts which were used for

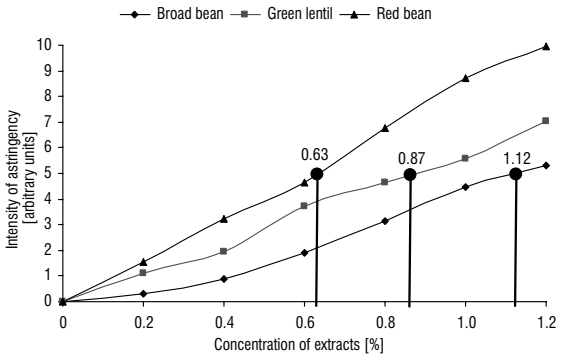

FIGURE 1. Mean results of the intensity of astringency sensation in selected extracts and an exemplary calculation of Astringency Sensation Indices (SAI).

calculations were presented in Table 2. It was shown that the sensory astringency of the extracts measured with the SAI values was diversified and varied between 3.84 (faba bean) and 7.93 (red bean). The results obtained proved the following descending order of the sensory astringency of the extracts: red bean > Adzuki bean > red lentil > green lentil > pea > broad bean > faba bean. It should be emphasised, however, that in both methods of analysis the extracts of broad bean, faba bean, and pea demonstrated a considerably lower intensity of astringency than the other extracts.

The analysis of correlation (Figure 2) showed a statistically significant correlation ($p \leq 0.05$; $r = 0.77$) between the sensory and the "chemical" astringency of the extracts. However no statistically significant correlation was found between the sensory astringency and total phenolic compounds.

TABLE 2. Astringency Sensation Indices (SAI) of phenolic extracts from legume seeds.

Extract	Astringency Sensation Indices [SAI]	Extract concentration [%] by which the astringency intensity is equal to 5 units
Faba bean	3.84	1.30
Broad bean	4.46	1.12
Adzuki bean	6.94	0.72
Red bean	7.93	0.63
Pea	5.61	0.89
Red lentil	6.41	0.78
Green lentil	5.71	0.87

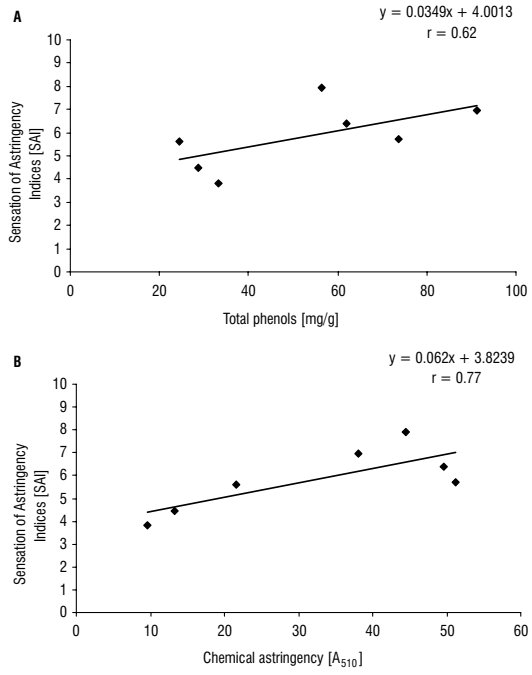

FIGURE 2. Relationship between Sensation of Astringency Indices (SAI) and A – total phenols, B – chemical astringency.

CONCLUSIONS

In conclusion, we found that the astringency of phenolic extracts, determined by sensory scalling, was positively correlated with the chemical astringency determined spectrophotometrically. It should be elucidated, however, whether the sensory astringency of the extracts is determined exclusively by tannins or also by tannin-free compounds. That issue is the objective of the next research of the authors.

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