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EFFECT OF HYDROCOLLOIDS ON PERCEPTION OF BITTERNESS AND ASTRINGENCY IN MODEL SYSTEM

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The influence of food gums (guar, xanthan, arabic) and carboxymethylcellulose (CMC) on bitterness and astringency of caffeine and tannic acid has been studied. The study was performed in critical concentrations (*c**) for particular hydrocolloids as well as for values above and below *c**. The ability of hydrocolloids to reduce the astringency and bitterness was evaluated using the method of taste indicator and expressed as a percentage of unreduced sensation. The results indicated that the ability of hydrocolloids to mask the astringency and bitterness was differential and depended both on the concentration and the type of the hydrocolloids used. CMC indicated the highest ability to mask bitterness and astringency among the hydrocolloids. It was found that the ability of these polymers to reduce the astringency was increasing above the *c** concentrations.

INTRODUCTION

There is currently much interest in the phytochemicals (non-nutrient substances) as bioactive components of foods. These substances are represented by phenolic compounds (phenolic acids, flavonoids, tannins), glucosinolates, saponins, and some alkaloids. Recent studies have proven that phytochemicals exert a favourable effect on human health and are recommended as components of health-promoting food. On the other hand, the consumption of food and beverages rich in non-nutrient components is often associated with the sensation described as astringency and bitterness [Groeneweg & Jongen, 1998; Ismail *et al.* 1981; Lea & Arnold 1978; Noble 1990; Troszyńska 2004]. These sensory attributes are perceived as having negative hedonic value and can be one of the most substantial reasons for the limited use of food. The problems can be solved by trying to mask bitter taste and astringency of these substances.

The aim of the study was to determine whether bitterness and astringency would be reduced by hydrocolloids which are commonly used in food as structure-forming substances. A model system was used in this study in order to eliminate sources of interaction. Caffeine and tannic acid were selected as taste stimuli because they are typical compounds of bitter taste and astringent sensation. These substances are often used as referential standards in a sensory analysis.

MATERIAL AND METHODS

Material. Hydrocolloids such as guar gum, xanthan gum, arabic gum and modified cellulose (carboxymethylcellulose - CMC) were all pure grade reagents and were purchased from Sigma, Aldrich Chemie Gmbh. However, the commercial hydrocolloids of the same type as above, were obtained from Agnex, Białystok. Caffeine and tannic acid were from Sigma, Aldrich Chemie Gmbh. The bitter taste was represented by 0.2% of caffeine, and the astringency by 0.2% of tannic acid. Preliminary tests showed that these concentrations of standards were above the threshold level but still within the range found in plants.

Instrumental analyses. Viscosity of hydrocolloid solution was measured with a rotary viscometer Rheotest 2 Type RV2 (MLW, Germany). The tests were conducted at 20°C at a shear rate of 240.57 s^{-1}. The concentration *versus* viscosity plot was calculated for each type of hydrocolloid. On the basis of the obtained curves the critical values (coil overlap value - *c**) for particular hydrocolloids were computed according to Cook *et al.* [2002]. The manner of *c** calculation is shown in Figure 1. Concentrations of individual hydrocolloids in matrices are given in Table 1. Results are means of three replications.

Sensory evaluation. A sensory panel consisted of nine members previously selected and trained according to ISO guidelines [ISO 8586-1:1993]. Four of them were familiarised with bitterness and astringency evaluation by participation in previous related study [Troszyńska *et al.,* 2006]. One formal session was preceded by a training sessions to familiarise the panelists with the masking concept of bitterness and astringency.

The thresholds of detection and recognition of standards were established according to PN-ISO 3972:1998.

The ability of hydrocolloids to reduce the astringency and bitterness was evaluated using the method of taste indicator

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TABLE 1. The critical coil overlap concentration (c*) of hydrocolloids and concentration above and below c*.

Hyrocolloid	c* (%)	Concentration above and below c* (%)
Sigma		
Arabic gum	1.99	0.99; 2.98
Guar gum	0.28	0.14; 0.42
Xanthan gum	0.39	0.19; 0.58
CMC	2.28	1.14; 3.42
Commercial		
Arabic gum	2.09	1.04; 3.13
Guar gum	0.27	0.13; 0.40
Xanthan gum	0.44	0.22; 0.66
CMC	0.39	0.58; 0.19

[Katsuragi *et al.*, 1997]. From each standard (caffeine and tannic acid) five aqueous solutions in the range of 0.0, 0.05, 0.10, 0.15, and 0.2 have been prepared from a 2% stock solution in redistilled water. For testing 10 mL volume individual samples were prepared, coded and presented in random to each panel member. The subject was requested to compare taste intensity of a test (hydrocolloid with caffeine or tannic acid) with that of the standard solution and to select the standard solution

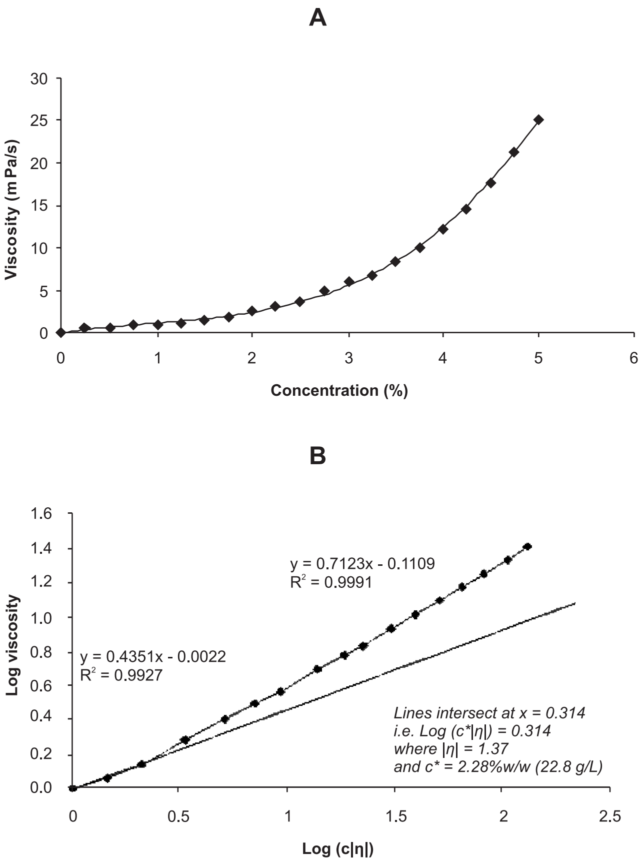

FIGURE 1. Determination of c* for CMC Sigma; A - characteristic curve dependence of viscosity (mPa/s) and concentration (%); B - determinate c* for CMC Sigma.

TABLE 2. Threshold value of bitterness and astringency of standards.

Referential substances	Detection threshold (%)	Recognition threshold (%)
Caffeine	0.006	0.02
Tannic acid	0.003	0.008

with taste intensity equivalent to that of the given test solution. The results were expressed as a percentage of unreduced sensation. As astringency and bitterness are quite persistent sensations, 3 min break was taken between the samples, during which the panellists were asked to eat unsalted biscuits as a neutraliser and rinse thoroughly their mouths with spring water. The assessments were carried out at a sensory laboratory room fulflilling requirements of the ISO standards [ISO 8589: 1998]. The results are based on means from nine individual issues of three replications.

RESULTS AND DISCUSSION

The threshold values of detection and recognition of standards (caffeine and tannin acid) are presented in Table 2. The first threshold is the minimum concentration which can be detected without any requirements to identify or recognise the stimulus, while the second one is the minimum concentration at which the stimulus can be identified or recognised. The concentrations accepted as the threshold values were those corresponding to 75% of positive panellists' answers. The results indicated that the detection threshold values for caffeine and tannic acids were similar: 0.006% and 0.003%, respectively. However, greater differences were observed in the recognition thresholds of standards and were as follows 0.008% for the tannic acid and 0.02% for caffeine, respectively. The results obtained proved that astringent and bitter compounds may be significant factors limiting food consumption.

Figures 2, 3, 4 and 5 show the effects of hydrocolloidal matrices on the astringency of tannic acid as a function of hydrocolloid concentrations. The results indicated that the ability of hydrocolloids to mask the astringency was differ-

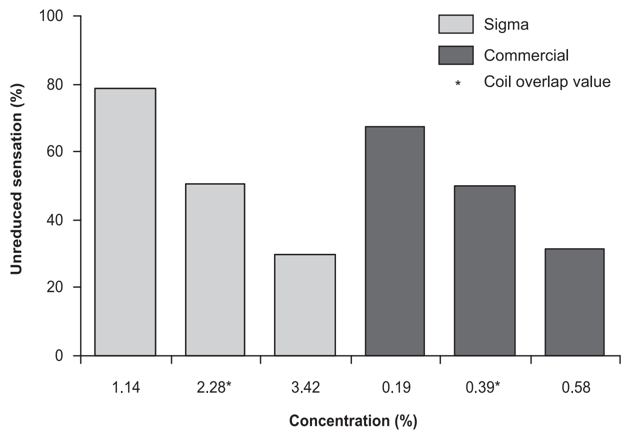

FIGURE 2. Percentage feeling of astringency in c* and concentration above and below for CMC.

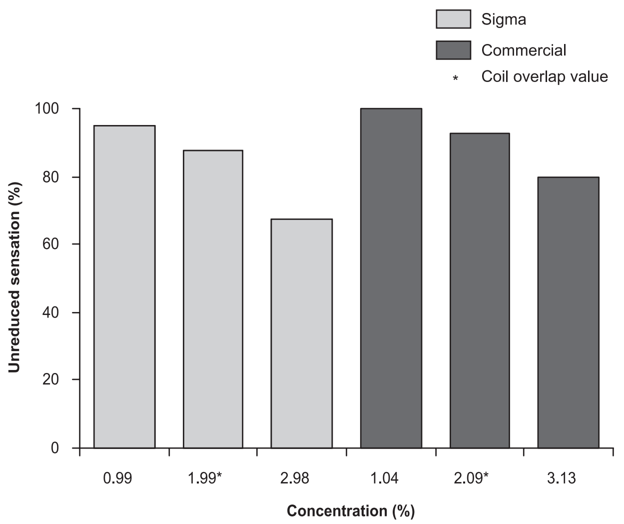

FIGURE 3. Percentage feeling of astringency in c* and concentration above and below for arabic gum.

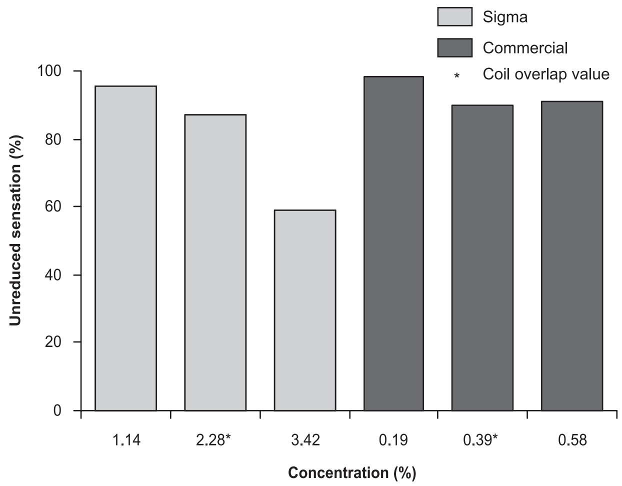

FIGURE 6. Percentage feeling of bitterness in c* and concentration above and below for CMC.

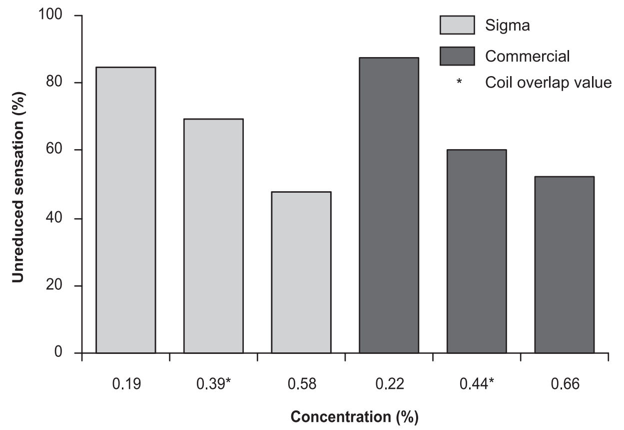

FIGURE 4. Percentage feeling of astringency in c* and concentration above and below for xanthan gum.

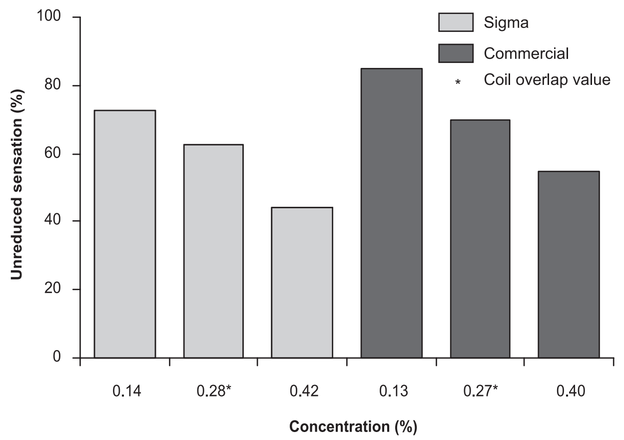

FIGURE 5. Percentage feeling of astringency in c* and concentration above and below for guar gum.

ential and depended both on the concentration and the type of hydrocolloid used. It was found that the astringency in aqueous solutions was strongly reduced above the point of random coil overlap (*c**) of hydrocolloids, *i.e.* in the concentration at which the individual biopolymer chains start to overlap and which is associated with a sharp increase in the solution viscosity. The percentage of unreduced astringency above *c** values ranged from 26.25% (CMC Sigma) to 80% (commercial arabic gum) whereas these values for *c** were from 43.75% (CMC Sigma) to 92.5% (commercial arabic gum). Below *c** values no significant effect of hydrocolloids on astringency was observed. In these concentrations the percentage of unreduced astringency ranged only from 67.5% (commercial CMC) to 100% (commercial arabic gum). The ability of hydrocolloids to reduce the astringency decreased in the following order: CMC (Sigma) > CMC (commercial) >guar gum (Sigma) > xanthan gum (Sigma) > xanthan gum (commercial) > guar gum (commercial) > arabic gum (Sigma) > arabic gum (commercial).

The results proved that among the investigated hydrocolloids only CMC suppressed the bitter taste of caffeine. Figure 6 shows the effects of CMC on the bitterness of caffeine as a function of CMC concentrations. Similarly to astringency, the highest masking of bitterness was observed above *c**. In this concentration the percentage of unreduced bitterness was 59% whereas in *c** and below *c** these values were higher and accounted for 92.5% and 95%, respectively.

CONCLUSIONS

The results indicated that CMC above critical concentrations (*c**) was the best astringency masker among the investigated hydrocolloids. Nowadays, little is known about the mechanisms which may mask the astringency. It seems likely then that viscosity of CMC may reduce the perceived friction when the salivary lubrication is reduced by precipitation or binding of salivary proteins by astringents. The role of CMC matrix in astringency masking will be further explored in future studies.

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REFERENCES

1. Cook D.J., Hollowood T.A., Linforth R.S.T., Taylor A.J., Perception of taste intensity in solutions of random-coil polysaccharides above and below c*. Food Qual. Pref., 2002, 13, 473-480.
2. Groeneweg B., Jongen W.H.F., The glucosinolates sinigrin and progoitrin are important determinants for taste preference and bitterness of Brussels sprouts. J. Sci. Food Agric., 1998, 78, 30-38.
3. Ismail F., Vaisey-Genser M., Fyfe B., Bitterness and astringency of sinapine and its components. J. Food Sci., 1981, 46, 1241--1244.
4. Katsuragi Y., Kashiwayanagi M., Kurihara K., Specific inhibitor for bitter taste: inhibition of frog taste nerve responses and human taste sensation to bitter stimuli. Brain Res. Prot., 1997, 1, 292-298.
5. Lea A.G.H., Arnold G.M., The phenolics of ciders: bitterness and astringency. J. Sci. Food Agric., 1978, 29, 478-483.
6. Noble A.C., Bitterness and astringency in wine. 1990, in:Bitterness in Food and Biverages (ed. R. Rousseff ed.). Elsevier Science Publishers, New York, pp. 145-148.
7. ISO 8586-1: 1993. Sensory analysis- General guidance for selection, training and monitoring of assessors-Part 1: Selected assessors.
8. PN-ISO 3972: 1998. Methodology- Method of investigating sensitivity of taste.
9. ISO 8589:1998. Sensory analysis – General guidance for the design of test rooms.
10. Troszyńska A., Non-nutrient bioactive substances in food of plant origin causing bitterness and astringency. Pol. J. Food Nutr. Sci., 2004, 13/54, SI, 65-73.
11. Troszyńska A., Amarowicz R., Lamparski G., Wołejszo A., Baryłko-Pikielna N., Investigation of astringency of extracts obtained from selected tannins-rich legume seeds. Food Qual. Pref., 2006, 17, 31-35.

BADANIE WPŁYWU HYDROKOLOIDOWYCH UKŁADÓW MODELOWYCH NA PERCEPCJĘ SENSORYCZNĄ GORYCZY I CIERPKOŚCI

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Celem pracy było zbadanie w układach modelowych zdolności hydrokoloidów polisacharydowych do maskowania/redukcji goryczy i cierpkości. W eksperymentach jako wzorce referencyjne przyjęto kwas taninowy (wzorzec cierpkości) i kofeinę (wzorzec goryczy). Do przygotowania modelowych układów hydrokoloidowych wykorzystano naturalne gumy roślinne takie jak guar, ksantan, arabska, oraz modyfikowaną celulozę (karboksymetyloceluloza - CMC). Badania wykonano w stężeniach krytycznych (c*) dla poszczególnych hydrokoloidów oraz powyżej i poniżej wartości c*. Wykazano, że zdolność hydrokoloidów do redukcji goryczy i cierpkości, wyrażona w procentach niezredukowanego wrażenia, była zróżnicowana i zależała od rodzaju użytego biopolimeru oraz od zastosowanych stężeń. Stwierdzono, że po przekroczeniu stężeń krytycznych, zdolność hydrokoloidów do redukcji cierpkości wzrastała. Sugeruje to, że lepkość odgrywała istotną rolę w percepcji tego sensorycznego wyróżnika. Wykazano, że spośród badanych hydrokoloidów CMC najskuteczniej niwelowała cierpkość kwasu taninowego i gorycz kofeiny.