

Original Article

Use of tea extracts (*Camelia sinensis*) in jelly candies as polyphenols sources in human diet

Anna Gramza-Michalowska PhD¹ and Julita Regula PhD²

¹Department of Food Technology and Human Nutrition, The Agricultural University of Poznań, Poland

²Department of Human Nutrition and Hygiene, The Agricultural University of Poznań, Poland

Diet rich in polyphenols may be important factor in preventing cardiovascular, neoplastic diseases and slowing down the aging processes. Because tea (*Camelia sinensis*) is most popular beverage containing relatively large amounts of polyphenols, it could be tremendously important source of polyphenolic constituents in human diet. However, there has been no data on the tea extracts use in particular everyday snacks. Objective of the study was to investigate potential use of tea polyphenol extracts in jelly candies, its taste, colour, consistency and general consumer's acceptance. Sensory analyses were conducted on two kinds of sweet jellies, with gelatin and agar used as thickening agents. As polyphenol source green and black tea extracts (*Camellia sinensis*) were used at concentration of 1.0% and 1.5%. Total polyphenol content in jellies ranged between 245.9-1256.5 mg/100g of candies and EGCG (epigallocatechin gallate) strong antioxidant content ranged between 3.2-170.1 mg/100g of candies. Sensory analyses included evaluation of overall appearance, colour, taste, aroma, consistence (homogeneity, clot presence) and clarity of jellies. Comparison of two thickening agents resulted in better properties of gelatin jellies according to its quality: colour, clarity, consistence, taste and aroma ($p < 0.05$). It was found that agar containing jellies were not so clear and aromatic as compared with gelatin ($p < 0.05$). Colour and overall appearance was also much more acceptable by the consumers in gelatin jellies. According to tea extract used it was found that ethanol extracts resulted in lower acceptance for overall acceptance and consistency ($p < 0.05$). Present study indicated that tea polyphenols extracts were accepted by consumers as food product constituents, and might be an interest of wider usage as food components.

Keywords: tea leaves, *Camellia sinensis*, tea extracts, polyphenols, sweet jellies, sensory analysis, consumers acceptance

Introduction

Tea leaves infusion (*Camelia sinensis*) is the most popular beverage containing large amounts of polyphenols, and it could also be important source of those constituents in human diet. There are many studies providing strong evidence that these compounds possess antioxidant capacity helping preventing many diseases.¹⁻⁵ Although researchers provided many promising results, to understand tea polyphenols benefits and its contributions to human health many studies are needed. The family of plant polyphenols consists of many compounds, differing chemical structure and possessing variable biological properties.^{6,7}

Ancient Chinese medicine used tea leaves infusion for its pharmacological proprieties for many centuries. Results of latest investigations seem to confirm this thesis.⁸⁻¹² Tea infusion consumption advantages are highly dependent on absorption and metabolism of its components. Because majority of polyphenolic compounds, except catechins, are present in plant in the form of β -glycosides, absorption of flavonoids with diet was not considered important.¹³ The sugar moiety is very important determinant of the flavonoids bioavailability, presence of glucose allows enlarging the flavonoids absorption. Absorption of the catechins in form of aglycones however, has not been explained yet.¹⁴ Research showed that food polyphenols can be absorbed from digestive tract, penetrate to blood, binding to albumins, which probably mask their antioxidant activity.

Simple flavonoids undergo disintegration (hydrolysis) in stomach, becoming accessible to absorption and working as antioxidants.^{16,17}

Many researches have opened new fields to possess the knowledge of polyphenols biological activity and bioavailability.¹⁸⁻²⁶ However it is still unclear which phenols are associated with certain activities in human body cells, what is the activity mechanism, the distribution in body tissues and what is their stability in living cells. There are still many questions unanswered.

Tea leaves (*Camelia sinensis*) containing relatively large amounts of polyphenols, could be polyphenolic constituents source in human diet.²⁷ However, there has been no data on the tea leaves extracts use in particular everyday snacks. Objective of the study was to investigate potential use of tea polyphenol extracts in jelly candies, its taste, colour, consistency and general consumer's acceptance.

Materials and methods

Plant extract

Two kinds of tea leaves (*Camelia sinensis* L.) extracts were

Corresponding Author: Dr Anna Gramza-Michalowska, Department of Food Technology and Human Nutrition, The Agricultural University, Wojska Polskiego 31, 60-624 Poznań, Poland
Tel: +48 (61) 848 73 31; Fax: +48 (61) 848 74 31
Email: angramza@au.poznan.pl

chosen for the research (tea leaves were bought at specialty store The House of Tea, Poznan and origin from Yunnan province of China). Green tea aqueous and ethanol extracts and black tea aqueous extract were prepared according to method presented by Gramza *et al.*²⁸ Yunnan green and black tea leaves were bought at tea specialty store. Aqueous extracts were prepared by boiling grinded tea (100g) in ddH₂O (1000 ml), followed by stirring for 15 min at 80°C (procedure was repeated three times). Collected extracts were centrifuged after filtration (2700 x g, 15 min) and than lyophilized under vacuum (HETO). Ethanol extract were prepared after 24 hours maceration of leaves (100 g) in 95% ethanol (100 ml), at ambient conditions (procedure was repeated three times). Collected extracts were centrifuged after filtration (2700 x g, 15 min). Ethanol was evaporated on rotary evaporator (RVO 200A, INGOS). The powdered extracts were kept frozen (-18°C) until further use. Rate of production yield was as follows: green tea ethanol - 12,2%, aqueous extract - 23,1% and black tea aqueous extract - 18,8%.²⁸ The range of the extracts concentration was determined experimentally.

Jelly candies

Experiment included two kinds of sweet jelly candies, with use of agar (CERO Agar Agar-ROEPER - Germany) and pork gelatin [BRENNTAG - Germany] as thickening agents. The recipe was as follows: thickeners were dissolved in hot water, than the sugar (5%) and tea extract (0.0, 1.0 and 1.5%) were added into a mixture. All jellies were enriched in pea green pigment-0.001g/100mL of jellies (BRENNTAG) and ice tea lemon flavour-0.9 mL/100mL of jellies (GIVAUDAN-Switzerland), to give the consumers this same jellies appearance. After cooling jellies were formed in shape of a cube (2cm) and stored for two weeks in dry cool place (+4°C). No overall appearance changes have been noticed during one month storage.

Total polyphenols and EGCG content

The level of total polyphenols was determined, and results were expressed as catechin equivalents in mg/100g of the jellies according to method by Horwitz.²⁹ Tea extracts catechin-EGCG content was analyzed according to the method published by Khokhar *et al.*³⁰, with use of Merck-Hitachi model D-7000 HPLC with System Manager (HSM) software (flow rate 1.0 ml/min, sample injection volume 10 µl, column oven set at 30°C). Standards were freshly prepared for each series of analysis, and detection was carried out at 278 nm. The retention time and area of the analyte peak were compared with standard's. Results were expressed in mg/100g of jelly candies.

Sensory analyses

Sensory analyses included evaluation of overall appearance, colour, taste, aroma, consistence (homogeneity, clot presence), clarity of jellies and general consumers acceptance.³¹ Individual characteristic of the jellies was evaluated according to 5 points scale (1-absolutely not acceptable; 2-not acceptable; 3-acceptable; 4-desired; 5-highly desired). General consumer's acceptance was evaluated by hedonic scale method (1-10 points, where 1-not acceptable, 10-highly desired). Evaluating panel consisted of twenty three persons, especially trained before

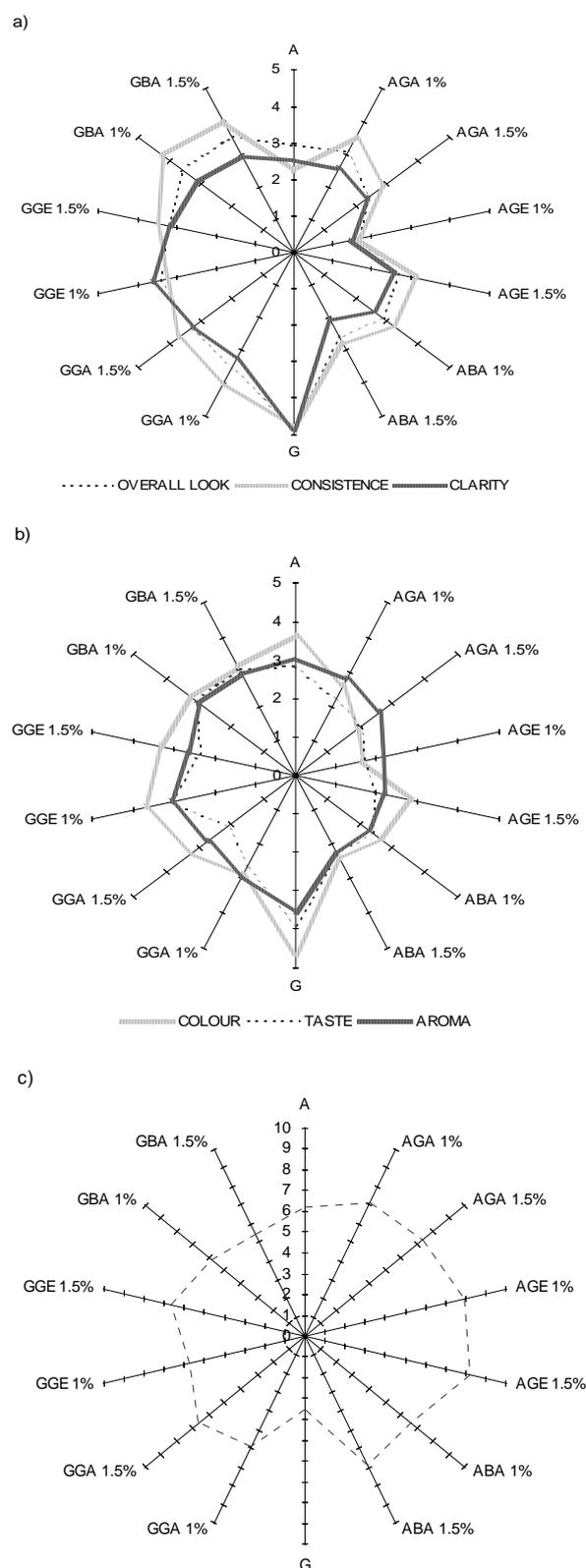


Figure 1. The influence of tea extracts use in jelly candies on sensory analysis: a, b- five points scale; c-hedonic scale (general consumers acceptance).

the evaluation.

Statistical analysis

Data were analyzed by the Kruskal-Wallis ANOVA rang analysis. Results were processed by the computer program *STATISTICA 7.0* (StatSoft).

Table 1. Total polyphenols and EGCG content in Yunan tea extracts jelly candies

Extract	Extract's content in jellies		Total polyphenols content [mg/100g] [#]	EGCG content [mg/100g] [#]
	[%]			
Green tea aqueous	1.0		302.3	60.5
	1.5		453.5	90.7
Green tea ethanol	1.0		837.7	113.4
	1.5		1256.5	170.1
Black tea aqueous	1.0		245.9	3.2
	1.5		368.8	4.8

Results presented as mean values of three replicates per two treatments, statistically differed in a column at ($p < 0.05$). TPC and EGCG content counted on the ground of received results published by Gramza et al 2006.²⁷

Results and discussion

Research was conducted on two kinds of sweat jellies, with gelatin and agar used as thickening agents. As polyphenol source green and black tea extracts (*Camellia sinensis*) were used at concentration of 1.0% and 1.5%. Sensory analyses included evaluation of overall appearance, colour, taste, aroma, consistence (homogeneity, clot presence) and clarity of jellies. Comparison of two thickening agents resulted in better properties of gelatin jellies according to its quality: colour, clarity, consistence, taste and aroma ($p < 0.05$). It was found that agar containing jellies were not so clear and aromatic as compared with gelatin ($p < 0.05$). Colour and overall appearance was also much more acceptable by the consumers in gelatin jellies. According to tea extract used it was found that ethanol extracts resulted in lower acceptance for overall acceptance and consistency ($p < 0.05$). Other quality indicators did not show any statistically important differences.

Description of tea extracts jellies with agar and gelatin was conducted. Gelatin jellies were intensive green colour, transparent gel, terse structure, no mudds were observed. Agar jellies however were no transparent ("milky"), but also intensive green colour and terse structure. As sensory analysis showed tea extracts are moderately desired by consumers, as measured by five points scale method.

Results of five points and hedonic scale sensory analysis presents Figure 1. Overall look of jellies was most acceptable by evaluators in samples GGE 1%, GBA 1% and 1.5% (Fig 1a). Agar was less acceptable, best notes approached were for AGA 1%, AGE 1% and ABA 1%. Best clarity was evaluated in gelatin samples (GGE 1%), agar jellies were called "milky". Evaluators concluded that gelatin jellies consistence was significantly better acceptable, agar had lower acceptance. According to jellies colour notes it was found that pure gelatin and GGE 1% reached best notes (Fig 1b). Among agar samples only AGE 1.5% was slightly acceptable by consumers. Also the taste of jellies was best in gelatin samples: GGE 1%, GBA 1% and 1.5%. Among agar best notes reached pure agar and ABA 1%. Best aroma was stated in GBA 1% and 1.5%, GGE 1%, GGA 1% and pure gelatin without extract added. Agar samples reached notes below three points. Hedonic scale showed overall consumers acceptance (Fig 1c). Results showed that in reverse to 5-points scale values, agar jellies were the samples evaluated on high level: seven to eight and a half points, gelatin however six to six and a half points.

Main polyphenols from tea leaves are: (+) - catechin

(C), (-) - epicatechin (EC), (-) - epicatechin gallate (ECG), (-) - epigallocatechin (EGC), (-) - epigallocatechin gallate (EGCG).³² EGCG is highly reactive constituent, having eight OH molecules, deciding about antioxidant activity.⁶ Research showed that green tea consists of higher amount of catechins than black tea.^{27, 33} Results of Mukhtar and Ahmad³⁴ research on tea extracts polyphenol content showed that a cup of green tea contains nearly 400 mg of antioxidants. Among those antioxidants about 200 mg represents EGCG. However Graham's evaluations³⁵ showed that only 90 mg represents EGCG in a cup of tea brew. Results of present research showed that total polyphenol content in jellies ranged between 245.9-1256.5 mg/100g of candies and EGCG content ranged from 3.2 mg/100g of a product for black tea to 107.1 mg/100g for green tea (table 1). Thus green tea extracts added to jelly candies allowed to increase polyphenol content nearly three times higher than in a average cup of tea.

Green tea is added to food products mainly as an antioxidant, there are no information about using tea extracts as polyphenol enrichment factor. In present study tea extracts were added as polyphenol sources, and potential taste and aroma carrier. Therefore it is difficult to make any comparisons with other research, because of there are no results about consumers acceptance of food products using tea extracts.

Conclusions

Present study indicated that tea polyphenols extracts were accepted by consumers as food product constituents, and might be an interest of wider usage as food components.

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Abbreviations used

A - agar without tea extract; AGA 1% - agar with green tea aqueous extract 1%; AGA 1.5% - agar with green tea aqueous extract 1.5%; AGE 1% - agar with green tea ethanol extract 1%; AGE 1.5% - agar with green tea ethanol extract 1.5%; ABA 1% - agar with black tea aqueous extract 1%; ABA 1.5% - agar with black tea aqueous extract 1.5%; G - gelatin without tea extract; GGA 1% - gelatin with green tea aqueous extract 1%; GGA 1.5% - gelatin with green tea aqueous extract 1.5%; GGE 1% - gelatin with green tea ethanol extract 1%; GGE 1.5% - gelatin with green tea ethanol extract 1.5%; GBA 1% - gelatin with

black tea aqueous extract 1%; GBA 1.5% - gelatin with black tea aqueous extract 1.5%.

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