The impact of energy drinks on the composite resin

Leszek Szalewski[1],
Magdalena Szalewska[2],
Przemysław Kleinrok[1],
Krystyna Skalicka-Woźniak[2],
Andrzej Bożyk[1]

[1] Department of Dental Prosthetics at Medical University of Lublin, Poland

[2] Students Scientific Society of the Department of Prosthetics at Medical University of Lublin, Poland

[3] Chair and Department of Pharmacognosy with Medicinal Plant at Medical University of Lublin, Poland

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Corresponding address:
Leszek Szalewski
Department of Dental Prosthetics at Medical University of Lublin
7 Karmelicka Street
20-081 Lublin, Poland
Leszek.Szalewski@gmail.com

Abstract

Background: Composite materials are nowadays very often used for direct reconstruction of damaged hard tissue of the teeth. They are aesthetical and have good mechanical properties. Beverages are often said to have negative influence on the mechanical properties of composite resins. Consumption of energy drinks has increased considerably over the last years. The low-pH energy drinks may also reduce durability of fixed dentures and composite fillings.
Objectives: The aim of this study was to check the impact of energy drinks on the composite resin.
Material and methods: For the purpose of the research 35 specimens made of BOSTON (Arkona) composite were prepared with ISO 4049/2010 norm. They were randomly divided into 7 groups and immersed in the selected drinks at the temperature of 37^0C for 7 days. The specimens were then tested for flexural strength.

Key words:
dental materials, tensile strength, beverages

Results: Energy drinks have negatively influence on the flexural strength of composite resins and the difference was highest for Adrenaline energy drink as compared to the control group.
Conclusion: Diet should be considered for patients using composite fixed dentures or fillings.

Introduction

Consumption of energy drinks has increased remarkably over the last years. Sales of energy drinks in the USA increased by 55% in 2002-2006 [1]. For Poland, this was 60% in 2008 [2]. Some studies show that as many as 28-31% of American 12-17-year-olds and 34% of 18-24-year-olds declare to consume such drinks regularly [3,4] As revealed in the research done by Arria et al., 10% of students consume energy drinks frequently, while 46-51% – rarely [5]. Since regulations within the European Community lack any clear definition of an energy drink, there are no mentions of their ingredients that would classify certain drinks as the energy ones. In the Polish context, the 'energy drink' name is attached to the beverages whose caloric value is similar to that of other fizzy drinks (e.g. Coca-Cola) and the main difference resides in the psycho-physical stimulation of the organism. Te ingredients of most drinks is similar and based on simple sugars, caffeine, taurine, taurynie, inositol, B vitamins, glucuronolactone and plant extracts. Most energy drinks contain approx. 30-35 mg of caffeine in every 100 ml. However, some of them referred to as 'energy shots' can contain as much as 350 mg in every 75 ml. Among the positive effects of consuming energy drinks their producers mention increased body function, better concentration, reduced tiredness and overcoming stress. Still, scientific studies do not yield unequivocal results: some prove their positive influence, others do not [6,7,8,9,10]. The list of side effects includes: heart pounding, headache, strong sense of malaise, annoyance, high level of stress, disturbance, increased systolic blood pressure or even platelets agregation which may lead to a heart attack [11,12,13]. One should also not forget about the effects energy drinks may cause in the oral cavity.

Aim

The aim of the research was to determine how composite materials change their properties when under the influence of the following energy drinks: Adrenaline Mountain Dew (PepsiCo), Black (Food Care), Burn (Coca Cola Co), Green Up (Herbapol Lublin S.A.), Rapid (Rapid), Tiger (Maspex). It is vital due to the increasing number of people who consume large amounts of these products. Flexural strength indicated the mechanical resistance of materials tested in the experiment.

Material and methods

In the study we used the Boston composite resin produced by Arkona Dental Pharmaceutical Laboratory. Boston is a micro-hybrid material which in 78% of its weight is built from a fillers of an average size of 0,72 μm. The specimens were immersed in distilled water (as a control group) and energy drinks whose composition are listed in Table 1. Table 2 presents the pH of these liquids as calculated using pH211 Microprocessor pHmeter which was manufactured by Hanna Instruments and calibrated using Hamilton Duracal Buffer solutions (Hamilton Bonaduz AG, Switzerland). pH of 5ml specimens of energy drinks was then measured twice a day for three consecutive days. Increased temperature and gas loss did not influence pH change.

The experiment was performed on a Boston A2 colour material. In order to assess its strength, specimens were made in line with ISO 4049:2000 norm and using a 2 x 2 x 25 mm steel mold [14]. The inside surface of the form was covered with a thin layer of vaseline to prevent sticking. The material was then condensed using dental pluggers,

Table 1.
Composition of energy drinks

Name	Ingredients
Adrenaline Mountain Dew	caffeine, taurine, ginseng, vitamins B2 and B12, pantoten acid
Black	caffeine, taurine, niacin, pantoten acid, vitamis B6 and B12, inositol
Burn	taurine, glukuronolactone, caffeine, inositol, guarana extract, niacin, pantoten acid, vitamins B6 and B12
Green Up	natural caffeine, guarana extract
Rapid	caffeine, taurine, niacin, pantoten acid, vitamins B6, B12 and B12
Tiger	taurine, caffeine, inositol, riboflavin, pantoten acid, vitamins B6 and B12

Table 2.
PH values of energy drinks in room temperature

	N	Mean	Minimum	Maximum	Standard deviation
Adrenaline	6	2.60	2.59	2.60	0.004082
Black	6	3.23	3.22	3.23	0.005477
Burn	6	2.66	2.66	2.67	0.005164
Green Up	6	2.75	2.74	2.76	0.010328
Rapid	6	3.43	3.42	3.44	0.007528
Tiger	6	3.39	3.38	3.39	0.005164
Distilled water	6	5.58	5.57	5.58	0.003845

and irradiated with LED Clear Blue LED Clear Blue with high power 1200 mW/cm^2. Each side of the specimens was irradiated in 5 points for 20 seconds and polymerized through a layer of polyethylene film in order to eliminate oxygen inhibition on the surface. Once hardened, the samples were carefully removed from the form to protect their edges. Any irregularities were smoothed with a Sof-lex (3M ESPE). Thereafter, the specimens were examined for the presence of air bubbles and defective specimens were excluded from the study.. During the first 24 hours after the polymerization all the specimens (n = 35) were stored in 37^{0}C distilled water. Then they were randomly divided into 7 subgroups of 5 and immersed for a week in the tested liquids (each at the temperature of 37^{o}C). This period was calculated on the basis of the algorithm applied by Gawriołek et al. [12] in their studies. The algorithm assumes that drinking a cup of coffee (approx. 150 ml) means that oral cavity comes into contact with the liquid for 1 minute. For an average person who takes approx. 750 ml (5 cups) of drinks per day, storing the specimens for 7 days can be compared to about 5 years in the oral cavity. After that the specimens were rinsed twice with distilled water, dried and tested for flexural strength.

Flexural strength was measured using a Zwick Roel Z010 testing machine with the opening width of 20 mm, initial gripping force of 1 N and crosshead speed of 0.75 mm/min. The specimens were measured to an accuracy of 0.01 mm before the test. Its end was marked by the specimen being crashed. Flexural strength was calculated using the following equation:

$S=3FL/2BH^2$

where F is the maximum load in Newtons exerted on the specimens; L gives is the distance (20 mm) between the supports, accurate to ±0.01 mm; B is the width (2 mm±0.01mm) of the specimens measured immediately prior to testing; and H is the height (2 mm±0.01mm) of the specimens measured immediately prior to testing.

Statistical calculations were done using Statistica 10 software.

Results

The results of the tests are presented in Table 3 and Figure 1. Energy drinks influence the flexural strength of composite materials. The lowest durability (100.70 MPa) was observed for Adrenaline drink (pH=2,60), whereas the highest equalled 119.18 MPa and was noted in the case of Tiger (pH=3.39). The specimens immersed in distilled water functioned as the control group.

Table 3.
Flexural strength of materials immersed in energy drinks

	N	Mean	Minimum	Maksimum	Standard deviation
Adrenaline	5	100.70	63.30	119.00	23.95
Black	5	109.28	85.80	134.00	21.39
Burn	5	113.98	86.90	142.00	19.55
Green Up	5	118.80	97.00	134.00	14.86
Rapid	5	106.92	81.40	143.00	26.76
Tiger	5	119.18	80.90	152.00	26.34
Distilled water	5	124.80	108.00	143.00	15.25

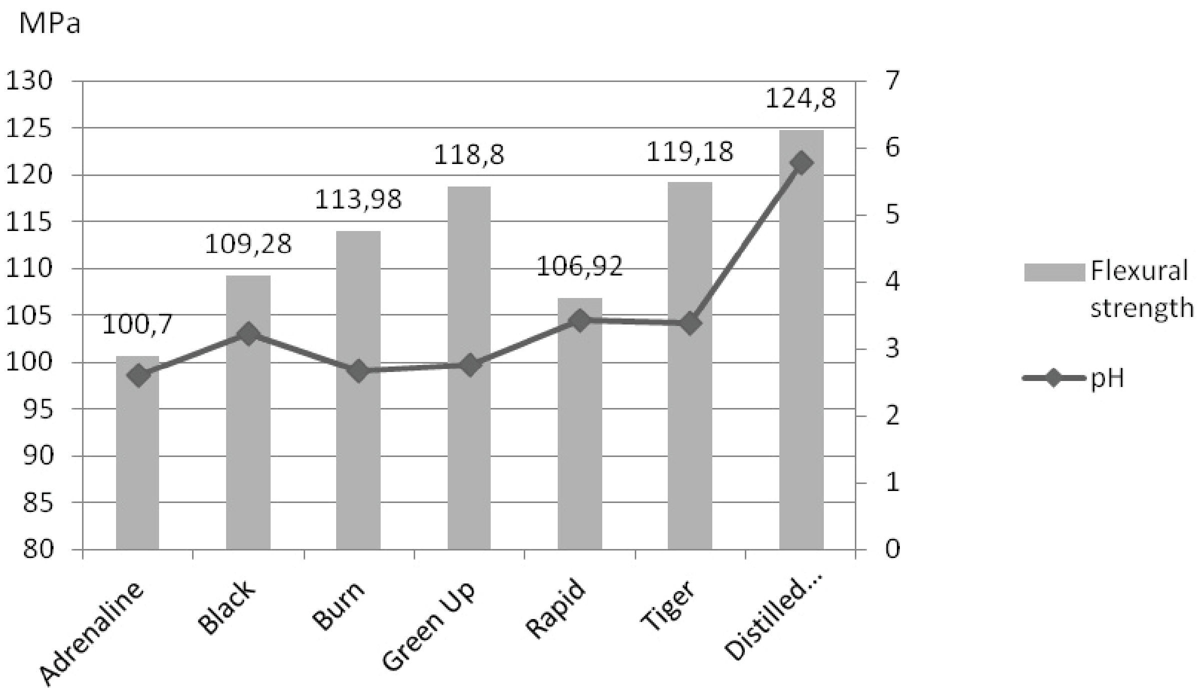

Fig. 1.
Contrasting composite resin's flexural strength with pH values of beverages

Discussion

The authors' own test was aimed at determining whether flexural strength of composite materials changes when they are immersed in energy drinks. Distilled water was the control group and was supposed to simulate the moist environment of the saliva-and-water-protected oral cavity. Composite materials used to rebuilt the lost dental hard tissues are permanently or temporarily exposed to different chemical factors found in the mouth and the chemicals found in drinks operate until the teeth are brushed. When ingredients found in drinks become attached to plaque in the inaccessible places, the contact becomes permanent. Food may also accumulate in excessive or irregular edges of fillings and its negative influence is much stronger due to inappropriate cleaning. Boston composite material was designed for filling both anterior and posterior teeth. In the case of the latter, composite durability is essential and thus often defined using the three point bending flexural test [16]. For this reason, we followed the same pattern when assessing the influence of energy drinks on composite materials. In the authors' own research, the mean values of flexural strength of most composites immersed in liquids for 7 days are beyond the level of statistical significance, which is also confirmed in other studies. However, it is worth noting that the decreased occurred and could be measured by calculating mean values of flexural strength. Based on other authors' observations, it can be concluded that longer immersion in the beverages tested would result in statistically significant changes. Despite searching numerous databases, including PubMed, Scopus, Science Direct, the authors did not manage to find many studies on the influence of energy drinks on composite materials. Since other beverages affect composites, energy drinks can be expected to do so as well. In many cases flexural strength did not show statistically significant differences after 7-day immersion in citric acid 0.1 M, lactic acid 0.1 M, ethanol heptane [17-19]. Longer incubation of the specimens in alcohol – 2 or 4 weeks – causes statistically significant decrease of flexural strength [20-22]. However, conclusions drawn from Lohbauer's research [23] question the purposefulness of testing the flexural strength of composites due to the fact that higher flexural strength does is not always matched by higher fatigue limit. Nevertheless, we may continue using the simpler bending test as long as ISO norms allow this method of assessment of composite materials. Similarly, Jyothi et al. [38], who tested mouthwashes, also confirmed alcohol's negative influence on composites. This is particularly important in view of the increasing popularity of mouthwashes among patients.

Conclusions

Within the limitations of this *in vitro* study, it may be concluded that the flexural strength of composite resins was influence by energy drinks. These findings may provide support to clinicians to recommend restricted intake of certain beverages and foods especially to patients with restorations and fixed dentures made of composite resins.

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