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ScienceDirect
Appetite 47 (2006) 315–323
Appetite
www.elsevier.com/locate/appet

Research report

Exposure, health information and flavour-masking strategies for improving the sensory quality of probiotic juice

T. Luckow[a,*], V. Sheehan[b], G. Fitzgerald[b], C. Delahunty[c]

[a]PepsiCo Company, 100 Stevens Avenue, Valhalla, NY 10595, USA
[b]University College Cork, Department of Food and Nutritional Sciences, College Road, Cork, Ireland
[c]Sensory Science Research Centre, Department of Food Science, University of Otago, PO Box 56, Dunedin, New Zealand

Received 16 March 2005; accepted 28 April 2006

Abstract

Probiotics are live microbial food supplements, which have been shown to exert numerous health benefits. Research has identified that probiotics cause perceptible off-flavours that often contribute to consumer dissatisfaction. This research consisted of three objectives. Firstly, to confirm whether probiotics have a significant effect on the sensory quality and the consumer acceptance of juices. Secondly, to evaluate whether the addition of tropical juices masks probiotic off-flavours, thereby increasing consumer liking. Thirdly, to determine whether non-sensory factors (i.e., repeated exposure, and health information) have an impact on consumer liking. Three orange juice products were manufactured for analysis; Control juice, juice containing probiotics, and juice containing probiotics and tropical fruit juices (10% v/v). Descriptive sensory analysis using a trained panel ($n = 8$) determined that probiotic juices possessed unique 'medicinal' characteristics. Using labelled affective magnitude scales, consumers ($n = 116$) evaluated their 'overall liking' of the three juices in a randomised order in the laboratory. Once assigned into one of three balanced exposure groups, each consumer took home seven, 100 mL bottles of one of the juices, and consumed one bottle each day for 7 days. After each in-home consumption, consumers evaluated their 'overall liking' to familiarize themselves with the juice. Furthermore, half of the consumers were provided with information about the presence and the health benefits of probiotics, while the other half of consumers received no information. After 7 days of in-home usage, consumers returned to the laboratory for post-exposure sensory testing, where they re-evaluated their 'overall liking' of the three juices in a randomised order. Results showed that tropical juices were effective in masking the off-flavours associated with probiotic ingredients, and that consumer liking for the probiotic juice containing tropical juice flavours was maintained over the 7-day exposure period. Exposure and information had significant effects on the 'overall liking' of juices containing probiotic cultures. A significant interaction between exposure and information was observed. Therefore, exposure, health information and flavour-masking techniques can have a positive effect on the hedonic qualities of probiotic juices.

Keywords: Orange juice; Probiotic cultures; Home-use test; Health claims; Sensory exposure

Introduction

The consumption of foods and beverages containing functional, probiotic microorganisms is a growing, global consumer trend (Verbeke, 2005). Probiotics are defined as live microbial food supplements, which upon ingestion in sufficient quantities exert health benefits including the improvement of the intestinal microbial balance (Fuller, 1989). Fruit juice has been suggested as a novel, yet appropriate medium for fortification with probiotic cultures because it is already positioned as a healthy food product, and it is consumed frequently and loyally by a large percentage of the consumer population (Tuorila & Cardello, 2002).

Numerous studies have shown that taste is the primary factor involved in the acceptance and purchasing behaviour of a variety of food categories (Grunert, Bech-Larsen, & Bredahl, 2000; Shepherd, 1990; Urala & Lähteenmäki, 2003) including functional foods (Verbeke, 2006). However, research has shown that perceptible off-flavours (e.g., dairy, medicinal, savoury) are associated

*Corresponding author. Tel.: +1 914 742 4935; fax: +1 914 742 4727.
E-mail address: tracy.luckow@pepsi.com (T. Luckow).

0195-6663/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.appet.2006.04.006

with probiotic orange juices (Luckow, Sheehan, Delahunty, & Fitzgerald, 2004b).

There is a variation in taste reactions to the off-flavours of healthy foods. Some suggest that age is the strongest predictor of reactions to off-flavours, whereby older respondents demonstrate a reduced aversion to off-flavours (i.e., bitter), compared to younger respondents (Drenowski, Ahlstrom Henderson, Hann, Barratt-Fornell, & Ruffin, 2002). This finding is suspected to be intensified by other factors including scaling behaviours, cognitive factors, or social aspects of older consumers (Barylko-Pikielna et al., 2004; Forde & Delahunty, 2004; Koskinen, Kälviäinen, & Tuorila, 2003; Kozlowska et al., 2003).

Genetics, including PROP taster status, and inherited taste factors have been shown to play a role in the determination of sensory acceptability of foods with off-flavours (Drenowski, Henderson, & Barratt-Fornell, 2001). Furthermore, cultural effects have been linked with human taste perceptions and hedonic responses (Rozin, 2003), whereby naturally aversive substances have become liked among specific cultural groups and function to identify acceptable foods (Rozin, Fischler, Imada, Sarubin, & Wrzesniewski, 1999).

However, off-flavours have also been shown to cause consumers to dislike a product, or to be unwilling to use it at a frequency required to obtain necessary health benefits (Tuorila & Cardello, 2002) (Luckow & Delahunty, 2004a). As a result, it is of commercial interest to compensate for the off-flavours caused by probiotic cultures in fruit juices, to improve the sensory acceptability to, and willingness to consume the product.

Masking is one technique that has been used to reduce the sensations of aversive odours and flavours in foods. It has been performed successfully through the addition of new substances or flavours to juices (Reinccius, 2000), and is therefore suspected to be capable of reducing the negative sensory attributes contributed by probiotic cultures. Tropical fruit juices (e.g., pineapple, mango, passionfruit) contribute strong, exotic aromatic and flavour contributions that may prevent consumers from identifying the probiotic off-flavours.

Non-sensory techniques have proven useful in enhancing the sensory quality of products despite off-flavours. The influence of exposure has been identified in many consumer studies (Bertino, Beauchamp, & Engelman, 1986; Birch & Marlin, 1982; Pliner, 1982; Rolls, 1984; Stein, Nagai, Nakagawa, & Beauchamp, 2003), whereby preference ratings have been shown to be enhanced or reinforced with exposure (Zajonc, 1968). Furthermore, when the frequency of exposure to a food stimulus is increased, food stimuli have been shown to be better liked (Pliner, 1982; Zajonc, 1968). Therefore, repeated exposure and increased familiarity to sensory off-flavours, may influence consumer attitudes in a positive way, therefore increasing willingness to consume probiotic juices.

Finally, providing consumers with information about the health benefits associated with probiotic cultures may improve the perceived sensory quality of probiotic juices. Health information has been shown to be a vital tool in the consumer acceptance of a variety of food products (Caporale & Monteleone, 2004; Deliza, Rosenthal, & Silva, 2003; Kähkönen & Turolia, 1999; Kähkönen, Turoila, & Rita, 1995; Kihlberg, Johansson, Langsrud, & Risvik, 2005; Stubenitsky, Aarom, Catt, & Mela, 1998; Tuorila, Andersson, Martikainen, & Salovaara, 1998; Tuorila & Cardello, 2002). After being provided with information about the health benefits of probiotic cultures, the uncharacteristic aromas and flavours might play a positive role in functional foods, as markers for the probiotic ingredients, and as proof of the action of the products (Juttlestad, 1998; Reineccius, 2000).

There were three main objectives to this study:

1. To confirm whether the addition of probiotic cultures to orange juices impacts the descriptive sensory profile and the consumer liking of orange juice. Furthermore, to evaluate whether the addition of tropical fruit juices (pineapple, mango, passionfruit) improves sensory quality and hedonics.
2. To confirm whether the consumer response to orange juices containing probiotic cultures changes upon exposure and familiarity to their sensory character.
3. To determine whether information about the health benefits of probiotic cultures impacts perceived sensory acceptability.

Materials and methods

Orange juice base

Pasteurised orange juice was treated with a Tetra Asept system (Tetra Pak Processing Systems, Lund, Sweden) at 76 °C for 12–15 s (Sunjuice, UK) and was shipped to Cork, Ireland immediately after production. It was handled and stored at 4 °C. When the pasteurised juice was presented to consumers on its own, it was designated as the Control sample.

Bacterial strain

The probiotic strain *Lactobacillus paracasei* ssp. *paracasei* NFBC 43338 was previously isolated from the human gastrointestinal tract (GIT), and was obtained from the culture collection at the University College Cork, Ireland. The strain was cultured overnight (17 h) in 10 mL MRS broth from a 1% (v/v) stock inoculum, and incubated at 37 °C. This was followed by a subculture step where 10 L of MRS was inoculated with a 1% inoculum and incubated under similar conditions for a further 17 h. Cells were harvested by centrifugation (10,000 rpm × 10 min), and then resuspended in 1/10 volume of pasteurised juice. A 1.5% inoculum of this culture concentrate was then inoculated into the pasteurised juice base. The initial numbers of probiotics present in the juice were determined