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Irradiation of strawberries: Influence of information regarding preservation technology on consumer sensory acceptance

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ABSTRACT

The rejection of irradiation by the population has decreased its utilisation by industries over the years. We aimed to study the impact that providing information about the treatment given to strawberries (irradiation) and additional information had on consumer acceptance. Three sessions of sensory acceptance were carried out, consisting of a blind test (S1), a test with information regarding the treatment given to strawberries (S2) and a test with information regarding the treatment along with a text explaining the irradiation process (S3). One non-irradiated and one irradiated (at 3.6 kGy) strawberry sample were served to 88 judges. The acceptance of the irradiated strawberry was positive but smaller than the control strawberry (S1 and S2) ($p \leq 0.05$). In S3, the overall acceptance of the samples did not differ. The text about the irradiation process showed a positive influence on consumer acceptance.
Industrial relevance: We present a study of the impact that providing information about the treatment given to strawberries (irradiation) and additional information about the process had on consumer acceptance. Our findings demonstrate the need to educate people about the irradiation process and its applications to reach higher acceptance and, consequently, to commercialise irradiated food. These results will help industries to adopt better strategies to obtain a higher acceptance of their irradiated products.

1. Introduction

The recent disease outbreaks due to the consumption of contaminated strawberries (CDC, 2010; Falkenstein, 2011; Goetz, 2011), resulting in large losses in the production chain (Vachon, D'Aprano, Lacroix, & Letendre, 2003), have demanded the use of new, more efficient preservation techniques.

Recently, food irradiation has gained more attention, appearing as a possible solution to increase the shelf life of fresh fruits and vegetables that are free of pathogenic microorganisms without strongly modifying their sensory attributes (FAO/IAEA, 2012; Lynch, Tauxe, & Hedberg, 2009; Prevor, 2007a).

Irradiation is scientifically accepted as an excellent preservation method and is approved in various countries. However, its high initial costs and the rejection of this technique by consumers, who find it difficult to evaluate its benefits or are ill informed, have limited the commercial progress of irradiated food (Ornellas, Gonçalves, Silva, & Martins, 2006).

Numerous studies have documented the rejection of irradiated food by much of the population (Consumers Association of Canada, 2012; Eustice & Bruhn, 2013; Gunes & Tekin, 2006; Junqueira-Gonçalves et al., 2011). However, this rejection has been decreasing over the years (Johnson, Reynolds, Chen, & Resurreccion, 2004; Martins, Behrens, Montes-Villanueva, Franco, & Landgraf, 2012). In addition, when consumers are informed about the irradiation process, they tend to not reject irradiated food and even prefer it over non-irradiated food (Gunes & Tekin, 2006; Huang, Wolfe, & Mckissick, 2007; ICGFI, 1999).

The consumer attitude towards food is very complex, as it is influenced by sensory and non-sensory attributes, as well as by the interactions between them (Della Lucia, Minim, Silva, & Minin, 2010; Guerrero, Colomer, Guàrdia, Xicola, & Clotet, 2000). Consumer concern regarding production and preservation technologies, contextual influences, social factors, health concerns, ethnic and cultural concepts and price have limited the use of food irradiation over the years.

Most studies on this topic use sensory acceptance tests to measure the influence of food irradiation on consumer behaviour. Thus, sensory tests enabling the comparison between the blind acceptance of a product, i.e., acceptance without disclosure of external characteristics, such as brand and other types of information, and acceptance when additional information is given have been an important tool to study the influence of various non-sensory factors on consumer perception (Della Lucia, Minim, Silva, & Minin, 2010).

Therefore, the objective of the present study was to evaluate the influence of information on the preservation treatment given to strawberries

Abbreviation: CRT, consumer rejection threshold.

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and additional information about the irradiation process on the sensory acceptance of irradiated strawberries.

2. Methodology

This study was approved by the Research Ethics Committee of the Centre of Health Sciences of the Universidade Federal do Espírito Santo — UFES, State of Espírito Santo (ES), Brazil under the number 65403.

2.1. Judges

The judges of this study were 55 women and 33 men aged between 18 and 44 years old who were regular consumers of strawberries. This group included students and staff of the Centre of Agricultural Sciences of the Universidade Federal do Espírito Santo (CCA-UFES) and residents of Alegre, ES, Brazil.

2.2. Materials

Strawberries (*Fragaria ananassa* Duch.) of the Camino Real variety, harvest of 2012, were provided by a producer in Guaçuí — ES. Strawberries with bright-red colour on 75% of their surface were harvested, as this was considered the optimal maturation for *in natura* commercialisation (EMBRAPA, 2005). Then, the strawberries were selected, placed in polyethylene terephthalate (PET) packaging and cooled in a conventional refrigerator at 8 °C for approximately 10 h.

2.3. Irradiation

After refrigeration, the strawberries were divided into two lots, one of non-irradiated strawberries (control) and another of strawberries that would be irradiated at a dose of 3.6 kGy, according to a completely randomised design (CRD). To ensure homogeneity of the storage conditions, both lots were stored in Styrofoam boxes with sealed plastic ice packs. These storage conditions prevented direct contact of the strawberries and the packs, thus preventing the occurrence of cold damage. The Styrofoam boxes of the control lot were stored in the laboratory of Sensory Analysis of CCA-UFES, while the boxes of the other lot were transported to the irradiation site. The storage temperature of both lots was approximately 8 °C.

Irradiation of the strawberries took place at 8 °C one day after harvest at the Laboratory of Gamma Radiation of the Centre for Development of Nuclear Technology, in Belo Horizonte — state of Minas Gerais (MG), Brazil. A cobalt-60 source was used in a multipurpose panoramic irradiator category II (MDS Nordion in Canada, Model/serial number IR-214 and type GB-127) with maximum activity of 2,200,000 GBq or 60,000 Ci.

At the irradiation of the fruit, the activity of the source was 1,838,177.02 GBq or 49,680.46 Ci. The strawberry was irradiated at a dose of 3.6 kGy at a dose rate of 1.872 kGy/h.

2.4. Sensory analysis

The sensory analysis was carried out at the laboratory of Sensory Analysis of CCA-UFES in individual booths under white light.

To study the influence of information on consumer acceptance, three sessions of sensory acceptance were carried out, consisting of a blind test, a test informing the treatment given to the strawberry and a third test informing which treatment was given to the strawberry along with a text explaining the irradiation process and its applications.

One control sample (non-irradiated) and one strawberry sample irradiated with a dose of 3.6 kGy were analysed in the three sessions. This dose was chosen because it was shown to be the consumer rejection threshold (CRT) calculated by Lima Filho et al. (2014). In the latter study, the CRT for the radiation dose was determined using the method proposed by Prescott, Norris, Kunst, and Kim (2005). Above a dose of 3.6 kGy, the non-irradiated strawberry (control) began to be preferred over the irradiated one.

The fact that one sample is preferred over the other does not mean that it has a positive acceptance, i.e., an acceptance evidenced on the positive region of the hedonic scale. However, in the method for measuring the rejection threshold proposed by Prescott et al. (2005), preference is compared between samples subjected to increasing intensities of a stimulus (treatment) and a control sample. To correctly execute the methodology, the control sample chosen by the researcher usually exhibits a positive acceptance by the consumer. That minimises the probability that a sample that did not statistically differ from the control with regard to preference would have a negative acceptance or rejection.

Ideally, when the dose approaches the CRT, a significant difference regarding the acceptance should also occur. Therefore, testing the acceptance between a sample submitted to the CRT dose and the control sample would corroborate the results obtained by Lima Filho et al. (2014). Considering that, the sessions of acceptance of the control and irradiated strawberries in the present study were carried out at a dose of 3.6 kGy. Thus, besides analysing the influence of information on the sensory acceptance of the irradiated strawberry, the sensory acceptance of the strawberry irradiated at the CRT dose was also studied. First, the judges answered a questionnaire to obtain sociodemographic data (gender, age group and educational level), their frequency of consumption of strawberries and their knowledge level of the food irradiation process. Then, each consumer carried out the three acceptance sessions with one session per day (Della Lucia, Minim, Silva, & Minin, 2010).

The samples were randomly and monadically presented to each judge in the three sessions. In addition to the samples, the judges received a sheet, where they were asked to indicate their acceptance of the product on a 9-point hedonic scale, assigning ratings that varied from “like extremely” (corresponding to 9) and “dislike extremely” (corresponding to 1) (Reis & Minim, 2010). The three sessions took place as follows:

Session 1 (blind test) — the judges tasted the two samples without receiving any prior information on whether the strawberry was submitted to the irradiation process. The acceptance of texture, taste and overall impression was evaluated.

Session 2 (test disclosing the treatment given to the strawberry) — the irradiated sample was served along with disclosure that a treatment was given to the strawberry (irradiated strawberry), while the control sample was served with the label “strawberry”. The consumer was asked to judge the overall impression of the samples while analysing the given information.

Session 3 (test disclosing the treatment given to the strawberry and providing additional information) — the control sample was served with the label “strawberry”. The irradiated sample was analysed together with the information of the treatment given to the strawberry (irradiated strawberry) and an explanatory text about the irradiation process as shown in Fig. 1. The judges were instructed to read the text before evaluating the sample. Both samples were analysed according to the overall impression.

The results of the tests are shown as simple frequency distribution plots. To better visualise and understand the results, the hedonic ratings were presented by dividing them into two groups: one corresponding to classes 1 to 5 (“dislike extremely” to “neither like nor dislike”) for the judges that did not like the strawberry, and the other to classes 6 to 9 (“like slightly” to “like extremely”) for the judges that liked the strawberry. The hedonic rating “neither like nor dislike” was considered as a negative response, as judges that are indifferent to a product usually are not inclined to consume it (Della Lucia, Minim, Silva, Minim, & Ceresino, 2010).

Analysis of variance (ANOVA) was carried for each attribute in each acceptance session. For each sample, the differences (deviations) between