

GSICA

GSICA
THE ITALIAN SCIENTIFIC GROUP
OF FOOD PACKAGING



SLIM 2010

Shelf-life International Meeting

Zaragoza, 23 – 25 June 2010

Edited by

CRISTINA NERÍN & JESÚS SALAFRANCA

Special Issue

ITALIAN JOURNAL
OF
FOOD SCIENCE

CHIRIOTTI  EDITORI

GSICA

THE ITALIAN SCIENTIFIC GROUP of
FOOD PACKAGING

In cooperation with

**THE ARAGÓN INSTITUTE OF ENGINEERING
RESEARCH (13A) OF THE UNIVERSITY OF ZARAGOZA**



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This Special Issue of the Italian Journal of Food Science collects the presentations given at the "SLIM 2010, Shelf Life International Meeting" organized by GSICA and the Aragón Institute of Engineering Research (I3A) of the University of Zaragoza, held at Zaragoza on June 23-25th 2010.

These papers were reviewed by the Scientific Committee of the congress before their presentation but they did not undergo the conventional reviewing system of the Italian Journal of Food Science.

Chiriotti Editori S.R.L. - Pinerolo - Italy

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ISSN 1120-1770



ITALIAN JOURNAL OF FOOD SCIENCE
(RIVISTA ITALIANA DI SCIENZA DEGLI ALIMENTI) 2nd series

SISTAL
Società Italiana di Scienze e Tecnologie Alimentari (S.I.S.T.A.I.)
www.sistal.it

Founded by Paolo Fantozzi under the aegis of the University of Perugia

Official Journal of the Italian Society of Food Science and Technology

Società Italiana di Scienze e Tecnologie Alimentari (S.I.S.T.A.I.)

Initially supported in part by the Italian Research Council (CNR) - Rome - Italy

Recognised as a "Journal of High Cultural Level"

by the Ministry of Cultural Heritage - Rome - Italy

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Publisher:

Alberto Chirioti

Chirioti Editori srl, Viale Rimembranza 60, I-10064 Pinerolo, Italy - Tel. +39 0121 393127 - Fax +39 0121 794480
e-mail: info@chiriotieditori.it - URL: www.chiriotieditori.it

Aim: The Italian Journal of Food Science is an international journal publishing original, basic and applied papers, reviews, short communications, surveys and opinions on food science and technology with specific reference to the Mediterranean Region. Its expanded scope includes food production, food engineering, food management, food quality, shelf-life, consumer acceptance of foodstuffs, food safety and nutrition, and environmental aspects of food processing.

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Frequency: Quarterly - One volume in four issues. Guide for Authors is published in each number and annual indices are published in number 4 of each volume.

Impact Factor: 5-Year Impact Factor: 0.596 published in 2009 Journal of Citation Reports, Institute for Scientific Information; Index Copernicus Journal Master List 2009 (ICV): 13.19

IJFS is abstracted/indexed in: Chemical Abstracts Service (USA); Foods Adlibra Publ. (USA); Gialline - Ensia (F); Institut Information Sci. Acad. Sciences (Russia); Institute for Scientific Information; CurrentContents@IAB&ES; SciSearch@ (USA-GB); Int. Food Information Service - IFIS (D); Int. Food Information Service - IFIS (UK); EBSCO Publishing; Index Copernicus Journal Master List (PL).

IJFS has a page charge of € 25.00 each page.

Subscription Rate: IJFS is available on-line in PDF format only.

2011: Volume XXIII: Ordinary € 50.00 - Supporting € 1,000.00

IMPROVEMENT OF CO₂ RETENTION OF PET BOTTLES FOR CARBONATED SOFT DRINKS

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ABSTRACT

One of the major aims pursued by the carbonated soft drinks industry is to extend the shelf-life of PET-packaged products, in order to guarantee the consumers with the original characteristics and quality. Most of the responsibility in the shelf-life extension of such products has to be attributed to the bottle material performances, such as the barrier properties to gases with special regards for the ability to maintain the internal CO₂ through the shelf-life. Tests on carbonated soft drinks bottles are performed at every change (design, volume, etc.) of the package, in order to verify the performances of the new bottle with special regards for the CO₂ retention properties.

The research aims at the evaluation of new bottles addressed to the packaging of a sugar free and a caffeine free carbonated soft drink (Coca-Cola Light e Coca-Cola Caffeine Free), recently launched on the Italian market. The start of commercialisation for these new products is the result of a project named "Silver and Gold", which takes the name from the new colours of the new bottles. Such bottles are produced using the same PET resin as the standard ones, with the only exception of master batch dyes used in the test materials. The CO₂ retention performances of Silver and Gold bottles were investigated in comparison with the standard bottle used as a control. Results showed that CO₂ retention was improved in the Silver and Gold bottles, which retained averagely 88% of the initial CO₂ level after 14 weeks of storage, approximately 10% more than the standard bottles.

Key words: carbonated soft drinks, CO₂ retention, PET additives, PET bottles, shelf-life.

INTRODUCTION

One of the major aims pursued by the carbonated soft drinks industry is to extend the shelf-life of PET-packaged products, in order to guarantee the consumers with the original characteristics and quality. The shelf-life of soft drinks is determined by the CO₂ level, which decreases due to permeation through the packaging material. Therefore, most of the responsibility in the shelf-life extension of such products has to be attributed to the bottle material performances, such as the ability to maintain the internal CO₂ through the shelf-life, that is, in other words, its barrier property to CO₂. Standard shelf-life of “The Coca Cola Company” products is fixed, as a function of the bottle size, to: 6 months: for PET bottles >1 litre; 5 months: for PET bottles <1 litre; 12 months: for glass bottles.

Sibeg s.r.l. follows specific guidelines, recommended by “The Coca-Cola Company” (Packaging Authorization for Non-Refillable Plastic Bottles), containing requirements, tools, specification, and test procedures needed to authorize a new package.

Apart from the controls routinely performed on the preforms (incoming inspection), tests on bottles addressed to the packaging of carbonated soft drinks are performed at every change (design, volume, etc.), in order to verify the correspondence of the bottle performances to standard specifications, with special regards for the CO₂ retention properties. Normally, the verification of gas retention properties is carried out in cases of substitution of the preform/bottle with a lighter one or in cases of change of supplier or resin (Coriolani *et al.*, 2006).

The research aimed at assessing the CO₂ retention performances of new bottles addressed to the packaging of Coca Cola Light and Coca Cola caffeine-free. These products in the new package were launched on the market as a result of marketing project named “Silver and Gold”, which takes the name from the new colours of the bottles. The study took into account the role of the colour of the bottle on consumers’ perception and, in parallel, the eventual effect of such colorants on bottle performances.

MATERIALS AND METHODS

Preforms used for Silver and Gold bottles are made with the same resin as Clear ones, with the only addition of masterbatch dyes. The test was performed on 1,5 L PET bottles obtained from Clear, Silver and Gold preforms, respectively. Samples were bottled and stored in the same conditions (product volume, temperature, gas volume, screw top torque strength), and the values of the Clear bottles were taken as reference, as this type of bottle is the standard one used for Coca Cola.

The CO₂ retention test protocol implied filling the bottles with 4,32 gas volumes (GV), corresponding to approximately 8,6 g/L (1 GV = 1.98 g/L). Samples were stored at 22°±1°C at 50% relative humidity. Twelve bottles were randomly chosen 24 hours after bottling, and the CO₂ content was evaluated on each bottle by means of a Zahm and Nagel piercing device with pressure gauge, collocated on the cap of the bottles. The cap was pierced by the device; the valve was opened in order to discharge the headspace pressure, and the instrument was calibrated to zero. Bottles were then put in a sonicator until stabilization of the manometer. The test was repeated after 2, 4, 6, 9, 12 and 14 weeks.

RESULTS AND DISCUSSION

A typical CO₂ loss for a 2 l bottle with an initial carbonation of 4 GV, ranges to about 0.3 GV after 3-4 days, due to absorption by the PET and to an increase of the volume of the bottle (around 2.5%), then the CO₂ loss rate slows down to 0.04 GV/week. According to guidelines, such level should not fall below 3.3 GV within established storage periods under the above-mentioned standard testing conditions. Storage periods are referred to as the “standard shelf-life” of the bottles and depend on bottle size. For bottles smaller than 1 liter, storage time is 12 weeks, for 1 liter bottles and larger it is set to 14 weeks. These periods correspond to the usual retailer procurement times.

After 14 weeks the Clear bottles showed a loss of 0.92 GV, with a final value of 3.40. The variation for Silver bottles, on the other hand, amounted to 0.52 GV, reaching 3.80 at the end of the test. Similarly, the variation for the Gold bottles ranged to 0.53, as a consequence the final value registered was 3.79 GV (fig. 1).

Unexpectedly, Silver and Gold bottles showed improved performances with respect to the reference Clear ones. The improved barrier to CO₂ allowed Silver and Gold samples to retain 88% of the initial gas level, while the standard

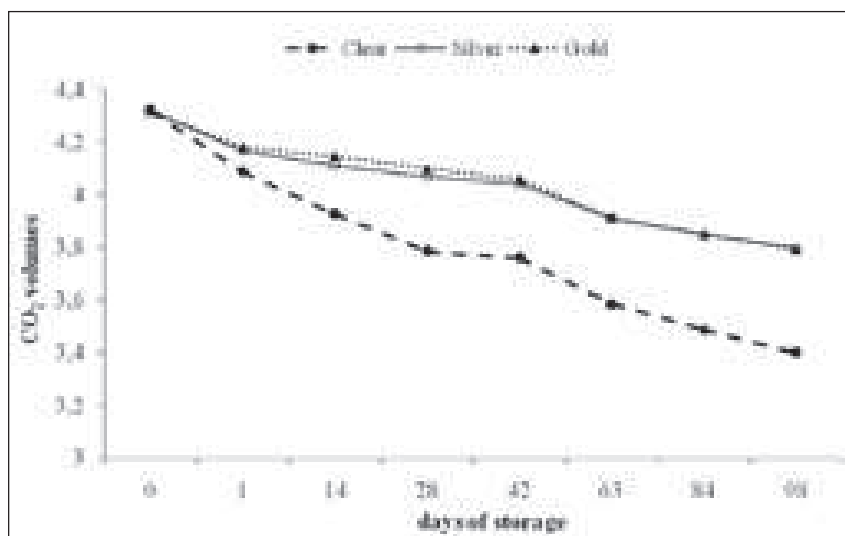


Fig. 1 - CO₂ (gas volumes) decay in Clear, Silver and Gold PET bottles as a function of storage time.

bottle could provide a retention of 78.7%. It has to be underlined that in any case the Clear bottles perfectly fulfil the requirements; however, a sensible improvement of performances has been achieved.

Bearing in mind that all bottles were produced from the same resin, with the addition of masterbatch dyes in the Silver and Gold samples, the result has to be attributed to the effect of such dyes which, together with an aesthetic function, perform a technological role by interfering with the microstructure of PET and reducing the available spaces for CO₂ to permeate (pores). Such effect resulted in the retention of 10% more gas compared with the PET standard bottles.

To sum up, the use of masterbatch dyes for the production of Silver and Gold bottles not only represents a marketing tool for attracting consumers and contributing to the identity of Coca-Cola light and caffeine free, respectively, but also bears the important side effect of prolonging the shelf-life of the beverage by improving the bottle CO₂ retention.

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