SLIM 2017

Shelf-life International Meeting

Bangkok (TH), 1-3 November 2017

Edited by

Klinkesorn U., Theerakulkait C. and Harnkarnsujarit N.

Special Issue

ITALIAN JOURNAL OF FOOD SCIENCE

Rivista italiana di scienza degli alimenti

CHIRIOTTI EDITORI

This Special Issue of the Italian Journal of Food Science collects the presentations given at the "SLIM 2017, Shelf-Life International Meeting" organized by the Italian Scientific Group of Food Packaging (GSICA), the Department of Food Science & Technology and Department of Packaging & Materials Technology, Faculty of Agro-Industry, Kasetsart University, Thailand, the ISEKI-Food Association (IFA), and Thailand Convention and Exhibition Bureau (TCEB), held in Bangkok, Thailand, on November 1-3, 2017.
These papers were reviewed by the Scientific Committee of SLIM 2017 before their presentation but they did not undergo the conventional reviewing system of the Italian Journal of Food Science.

Chiriotti Editori S.A.S. - Pinerolo - Italy

ISSN 1120-1770

ITALIAN JOURNAL OF FOOD SCIENCE

(RIVISTA ITALIANA DI SCIENZA DEGLI ALIMENTI) 2nd series

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.Al)
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

Publisher

Alberto Chiriotti - Chiriotti Editori srl, Viale Rimembranza 60, I-10064 Pinerolo, Italy - Tel. +39 0121 393127 - Fax +39 0121 794480 e-mail: alberto@chiriottieditori.it - URL: www.chiriottieditori.it

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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, energy and environmental aspects of food processing on the whole life cycle.

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Impact Factor

Impact Factor: 0.556 published in 2016 Journal of Citation Reports, Scopus CiteScore 2016: 0.84.
IJFS is abstracted/indexed in: Chemical Abstracts Service (USA); Foods Adlibra Publ. (USA);
Gialine - Ensia (F); Institut Information Sci. Acad. Sciences (Russia); Institute for Scientific Information; CurrentContents®/AB&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 publication charge of € 350.00 each article.

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Journal sponsorship is € 1,210.00

EFFECT OF *CYNARA CARDUNCULUS* EXTRACT ON THE SHELF LIFE OF AUBERGINE BURGERS

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ABSTRACT

Vegetable burger is a convenient processed food product exclusively prepared from non-meat ingredients. This research was intended to improve the shelf life of aubergine burgers with the addition of *Cynara cardunculus* extract characterized by a considerable presence of bioactive compounds. Two concentrations of extract were used for the preparation of aubergine burgers. Burger samples without *Cynara cardunculus* extract were prepared as control. Microbial load and sensory changes of vacuum-packed aubergine burgers were analyzed after 1 day, 30 days and 105 days of cold storage. The microbiological analyses were carried out during the shelf life test. The sensory profile method was used to measure any change in the sensory characters of samples, as a result of *Cynara cardunculus* extract treatment. Microbial growth observed values did not exceed the recommended limit, in particular yeasts were absent. The best sensory results were for samples prepared with 3% of *Cynara cardunculus* extract, especially on the attributes off-odour, off-flavour and overall. The control sample and the sample prepared with 1% of extract presented a low intensity of colour and firmness.

Keywords: aubergine, *Cynara cardunculus*, microbial load, sensory profile, vegetable burger

1. INTRODUCTION

Red meats are a rich source of animal fats that contain high amount of triglycerides, of saturated fatty acids as well as cholesterol. Recently, vegan substitutes for animal-based foods have become available; in particular, alternatives to cow's milk, including soy, almond and rice drinks. There are also yogurt, cheese, chicken and red meat vegan substitutes made of soy and/or other vegetable-based ingredients. Many of these products are made to resemble specific animal-based foods (MCILVEEN *et al.*, 1999). In the last years, the demand of consumers for veggie burgers has increased rapidly: in this context, vegetable burgers are convenient processed food products exclusively prepared from non-meat ingredients (ADISE *et al.*, 2015). Also, the demand for non-synthetic preservatives is increasing worldwide, such as antimicrobial compounds of natural origin, which should be not toxic for humans, environmentally safe, inexpensive and available in the market (MOHANKA and PRIYANKA, 2014). There is growing interest in using natural antimicrobial compounds, especially extract from plants, for the preservation of foods. Among these, *Cynara cardunculus* L. leaves, characterized by a considerable presence of bioactive compounds, is widely recognized for medical purpose, and the potential use of their extracts to control the growth of food pathogenic and/or spoilage microorganisms is at the beginning of investigation (ZHU *et al.*, 2004).
For vegetable burgers, the cooking process should significantly reduce the number of vegetative microbial cells and inactivate degradative enzymes. Consequently, spoilage of these products is primarily due to post-cooking contamination by microorganisms, which can be minimized by good hygiene and handling. The use of vacuum and long-term storage at refrigerated temperatures may promote the growth of psychrotrophic anaerobic/facultative anaerobic bacteria and yeasts allowing them to become dominant and deteriorate the product.
This research was intended to improve the sensory and microbiological shelf life of aubergine-based burgers with the addition of *Cynara cardunculus* extract characterized by a considerable presence of bioactive compounds.

2. MATERIALS AND METHODS

Two concentrations of extract were used (1% and 3%) for the preparation of aubergine-based burgers, indicated as Burger 1 and Burger 3, respectively. Burger samples prepared without *Cynara cardunculus* extract were taken as control (Burger C).
Microbial load and sensory changes of vacuum-packed aubergine-based burgers were analyzed at the processing day (t0), after 30 (t1) and 105 days (t2) of cold storage (4±1°C).

2.1. Preparation of extract

The *Cynara cardunculus* extract was prepared according to PANDINO *et al.* (2013).

2.2. Preparation of aubergine-based burgers

The following ingredients were added to prepare burgers for boiled and shredded eggplants: potatoes, onions, parsley, garlic, black pepper, nutmeg, dried tomato, thyme, salt, sugar, flour and maize starch, according to a consolidated industrial receipt (Terranèo Emozioni Siciliane srl, Vittoria, RG). The mixture obtained was given the form of 100g burgers, which were subsequently fried in sunflower oil for 40 seconds, cooled, vacuum-packed and refrigerated at 4°C.

2.3. Sensory analysis

The sensory profile method UNI 10957 (2003) was used to measure any change in the sensory characters of samples, as a result of *Cynara cardunculus* extract treatment. Twelve judges were trained (ISO 8586, 2012) in 4 sessions to familiarize with scales and procedures. The evaluation sessions were conducted in a sensory laboratory (UNI EN ISO 8589, 2010) from 11:00 a.m. to 12:00 a.m. in individual booths illuminated with white light. Randomized samples were evaluated by assigning a score between 1 (absence of sensation) and 9 (extremely intense), using five attributes (colour, firmness, off-odour, off-flavour and an overall assessment, expressed by considering all of the attributes). All data were acquired by a direct computerized registration system (FIZZ Byosistemes. ver. 2.00 M, Couternon, France).
The sensory data for each attribute were submitted to one-way ANOVA by the software package Statgraphics® Centurion XVI (Statpoint Technologies, INC.) using samples as factors. The significance was tested by means of the F-test. To differentiate the samples, the mean values were submitted to the multiple comparison test using the least significant difference (LSD) procedure.

2.4. Microbiological analysis

Total mesophilic and psychrotrophic bacterial counts, yeast count were determined on the samples. An aliquot (10 g) of burger was sterilely sampled from each package and homogenized with 90 mL of sterile physiologic solution in a Stomacher (Lab-Blender 400, Brinkmann, Westbury, NY, USA) for 30 s. The same diluent was used for subsequent decimal dilutions. The total mesophilic and psychrotrophic bacteria counts were performed on Plate Count Agar (PCA, Oxoid Ltd., Basingstoke, UK) with cycloheximide 0.1% solution (Oxoid), incubated, respectively, at 32°C for 24-48 h and at 4°C for 10 d; yeast count was carried out on Sabouraud Dextrose Agar (SDA, Oxoid) supplemented with chloramphenicol (0.1 g/L) incubated at 25°C for 48-72 h.
The microbiological counts, performed in triplicate, were expressed as log10 CFU/g of burger.

3. RESULTS AND DISCUSSION

3.1. Sensory analysis

Table 1 reports sensory attributes that significantly differentiated the burger samples during storage. The intensity (mean score) was reported only for the significantly different attributes.
All the attributes except for off-odour significantly differentiated the control burgers. At 105 days of storage there was a decrease of significative attributes. The attributes colour, firmness and overall significantly differentiated the Burger 1, while only the attribute colour and overall were significantly different for the Burger 3. Samples with 3% of extract had the highest intensity of overall score compared to the other samples at t1 and t2.

3.2. Microbiological analysis

Mesophilic bacterial counts of control burger (Burger C), burger supplemented with 1% extract (Burger 1) and with 3% extract (Burger 3) are shown in Table 2. Psychrotrophic

bacteria and yeasts were not detectable in any of the analyzed samples over the considered shelf life period.
The addition of *C. cardunculus* extract at 3% (v/w) completely inhibited the growth of mesophilic bacteria up to 30 d of refrigerated shelf life; in addition, the antibacterial effect of the extract persisted up to 105 d, since it significantly reduced mesophilic count by more than 1 log cfu/g, with respect to the unsupplemented burger sample.

Table 1. Mean scores of the significant sensory attributes.

Sample	Attribute	t0	t1	t2
Burger C	Colour	5.50±1.73^{b*}	4.87±1.17^{b}	3.75±0.48^{a}
	Firmness	5.87±1.69^{b}	5.25±0.83^{b}	3.50±1.50^{a}
	Off-flavour	5.12±2.03^{b}	4.87±1.90^{b}	2.87±0.78^{a}
	Overall	6.12±1.05^{b}	5.75±1.30^{b}	3.50±1.00^{a}
Burger 1	Colour	6.50±1.41^{b}	4.87±1.05^{a}	3.62±1.41^{a}
	Firmness	6.50±1.58^{b}	5.12±0.78^{a}	3.87±1.05^{a}
	Overall	6.50±1.00^{c}	5.12±0.93^{b}	3.87±1.05^{a}
Burger 3	Colour	6.00±1.32^{b}	5.25±0.97^{ab}	4.12±1.27^{a}
	Overall	8.00±1.39^{b}	6.00±1.00^{a}	6.00±0.99^{a}

*Values marked with different letters in the same row are significantly different ($p \leq 0.05$) according to the LSD multiple comparison test.

Table 2. Microbial counts of different burger samples throughout the refrigerated storage.

	t0	t1	t2
		log CFU/g	
Mesophilic bacteria			
Burger C	2.53	3.36	2.91
Burger 1	1.95	2.59	2.66
Burger 3	nd	nd	1.85

nd: not detectable (below the detection limit of plate count technique)

4. CONCLUSIONS

The present study showed the possibility of preparing a vegetable product without chemical preservatives. The addition of *Cynara cardunculus* extract has improved the sensory characteristics ensuring at the same time the microbiological stability of the product. As an additional advantage, the use of *C. cardunculus* extract allows to improve the nutritional quality of the product, with special regards for the antioxidant potential.

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