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1 **Honeybee-collected pollen for human consumption: impact of post-harvest conditioning**
2 **on the microbiota**
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4 RUNNING TITLE: Honeybee-collected pollen for human consumption
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23 SUMMARY
24 Bee pollen is gaining attention as functional food for human consumption. However, scanty
25 information is available on the effects of post-harvest conditioning methods on microbial

populations associated to bee pollen. Here, we assessed the microbiological quality and safety of bee-collected chestnut and willow pollen processed by different treatments, such as conventional, freeze- and microwave-assisted drying. Conventional drying of chestnut pollen significantly reduced the abundance of aerobic mesophilic bacteria and the contamination by enterobacteria and yeasts. No impact of freeze-drying and microwave-assisted conditioning was found on hygiene indicators. In chestnut pollen, microwave-assisted drying effectively reduced aerobic sporeforming bacteria, while all conditioning treatments strongly decreased coagulase-positive staphylococci. None of the conditioning methods allowed the reduction of moulds contamination and the abundance of sulphite-reducing clostridia. Our findings stress the importance of studying the microbiota of bee-collected pollen for human consumption, in order to process safe pollen with high microbiological quality.

Keywords: honeybee-collected pollen; pollen freeze-drying; pollen microbiota; pollen microwave-assisted conditioning; pollen post-harvest processing

INTRODUCTION. - Honeybee-collected pollen is gaining increasing attention as functional food for human consumption, due to antiproliferative, anti-allergic, antibiotic, antidiarrheic and antioxidant activities (MARGHITAS *et al.,* 2009; GRAIKOU *et al.,* 2011). Its healthy potential mainly depends on the high content of bioactive compounds, such as essential amino acids, antioxidants, vitamins and lipids (CAMPOS *et al.,* 2008; SOARES DE ARRUDA *et al.,* 2013; MĂRGĂOAN *et al.,* 2014; KRYSTYJAN *et al.,* 2015; ALMEIDA *et al.,* 2016). Among the different bioactive molecules, flavonoids have been reported as powerful antioxidant and antiradical compounds (LEJA *et al.,* 2007). Furthermore, it has been recently pointed out that a high level of omega-6 fatty acids characterized chestnut pollen, while willow pollen showed a high concentration of omega-3 fatty acids and carotenoids (CONTE *et al.,* 2016).

51 On the other hand, while basic knowledge on pollen biochemical and nutritional
52 properties is growing, little has been reported on the microbial contaminants potentially
53 present in this functional food and on its microbiological safety (BELHADJ *et al.,* 2012;
54 OBERSTEINER *et al.,* 2016). EC Regulation 178/2002 reported that chemical, physical and
55 biological agents could contaminate bee-collected pollen. Chemical agents may include
56 agricultural pesticides, environmental contaminants (e.g., heavy metals), toxic substances
57 from the plants visited by bees, with special reference to alkaloids, as well as detergents and
58 disinfectants. Pollen is also affected by atmospheric contamination with radionuclides, closely
59 reflecting air quality (BRUSA *et al.,* 2011). Lastly, biological contaminants may include
60 mycotoxins (CAMPOS *et al.,* 2008), bee young instars and their fragments, as well as parasitic
61 mites and other arthropods living in beehives (CANALE *et al.,* 2014a, b), and microbial
62 contaminants.
63 Concerning microbial contamination, recent studies have pointed out that bee-
64 collected pollen can be contaminated by bacteria (GILLIAM, 1979a; BELHADJ *et al.,* 2012),
65 yeasts (GILLIAM, 1979b; DE MELO *et al.,* 2015), and fungi (BRINDZA *et al.,* 2010; ESTEVINHO
66 *et al.,* 2012; FEÁS *et al.,* 2012). The latter are of particular interest for food safety, due to the
67 ability of several species to produce mycotoxins and to trigger allergic reactions (RYZHKIN *et*
68 *al.,* 2002). The most critical phase for pollen contamination is represented by the persistence
69 time of bee pollen in the traps positioned on beehives (GONZÀLEZ *et al.,* 2005). Notably, there
70 are no official criteria for microbiological safety of bee-collected pollen, both at the European
71 Community and international level (BOGDANOV, 2004; CAMPOS *et al.,* 2008). To overcome
72 this important gap, CAMPOS *et al.* (2008) proposed several microbiological standards for bee-
73 collected pollen (Table 1).
74 Fresh honeybee-collected pollen contains a relatively high amount of water (*i.e.* from
75 15 to 30%, w:w), which should be reduced in order to improve its physico-chemical stability

76 and to lower the chances of microbial growth (CANALE *et al.,* 2016). Classic pollen-drying
77 processes should be carried out at low temperatures, with short exposure times, lowering the
78 risk of Maillard's compounds formation (COLLIN *et al.,* 1995). In addition, drying processes
79 conducted at high temperatures and/or with scarcely standardized methods may play a
80 detrimental role on the content of polyphenols and flavonoids, leading to a decrease of the
81 food functional value (SERRA BONVEHÌ *et al.,* 2001). Therefore, novel and reliable
82 technologies are urgently needed in order to boost pollen shelf life and its high nutraceutical
83 quality. In this scenario, CANALE *et al.* (2016) recently showed that microwave-assisted
84 drying offers important advantages for the conservation of bee-collected pollen. Moreover,
85 also freeze-drying can be successfully used to reduce water content in honeybee-collected
86 pollen for human consumption, with negligible impact on polyunsaturated lipids (CONTE *et*
87 *al.,* 2016).

88 Scanty information is available about how post-harvest conditioning methods can
89 affect possible microbial contaminants associated to honeybee-collected pollen. In this work,
90 we investigated the microbiological quality of untreated bee-collected pollen from two
91 botanical species of high economic importance widespread in central Italy, *Castanea sativa*
92 (chestnut) and *Salix alba* (willow), by microbiological analyses, assessing colony forming
93 units (CFU). In particular, we assessed the occurrence and abundance of possible microbial
94 contaminants representing indicators of food hygiene and safety. Furthermore, we evaluated
95 the impact of several post-harvest pollen conditioning methods, including conventional
96 drying, freeze-drying and microwave-assisted drying, on key microbial contaminants.
97

98 MATERIALS AND METHODS. - *Chestnut and willow pollen samples*. - Honeybee-collected
99 chestnut pollen was harvested by a beekeeper in July 2015 in a natural chestnut forest located
100 in Castelnuovo Garfagnana (44° 06' 22.7"N 10° 24' 02.7"E, Lucca, Italy), using a pollen trap

101 (A. Metalori, Italy). Honeybee-collected willow pollen was harvested by a beekeeper in April
102 2015 in natural willow plantations located in Massa Macinaia (43° 47' 45.6"N 10° 32'
103 03.2"E, Capannori, Lucca, Italy), using the pollen trap mentioned above. Chestnut and willow
104 pollen samples were immediately frozen (-20 °C) and transferred to the laboratory within 2 h
105 (control). For both bee-collected pollens, their floral origin was checked by light microscopy
106 examination (400x magnification) and identified using pollen atlas databases (ERDTMAN,
107 1969; MARGHITAS *et al.,* 2009). Results showed that more than 80 % of the pollen grains
108 belonged to the two botanical species. Post-conditioning, all analytical results were compared
109 with the untreated pollen samples. All chestnut and willow pollen samples were analysed in
110 three replicates per pollen species and treatement, to evaluate the effect of conventional
111 drying [i.e. bee-pollen dried at 32 °C for 24 h in a Northwest Technology (Italy) cool-air
112 dryer, http://www.northwest-technology.com/] (CONTE *et al.,* 2016), freeze- and microwave-
113 drying.

114 *Freeze-drying and microwave-assisted drying*. - Pollen freeze-drying was carried out
115 using a lyophiliser Heto PowerDry® LL1500 (Thermo Fisher Scientific, Waltham,
116 Massachusetts, USA) following the method recently described by CONTE *et al.* (2016).
117 During the whole freeze-drying process, the temperature inside the condensation chamber was
118 -115 °C, with full vacuum. The samples, at the end of the treatment, were sealed and stored at
119 a temperature of -20 °C for subsequent analysis. Samples were stored in freezer at -20 °C
120 until analysed.

121 Microwave-assisted drying was carried out following the method described by
122 CANALE *et al.* (2016). Experiments were carried out at the absolute pressure of 50 mbar. For
123 both pollen types, microwave power was 150 W and the exposure time was 30 min. At the
124 end of the treatment, pollen samples were weighed and their temperature measured with a K-
125 type thermocouple. The pollen was transferred into an airtight container and stored at 20°C

126 until analysed. Thermo-gravimetric analysis (TGA) carried out as described by CANALE *et al.,*
127 (2016) was used to evaluate the water content in untreated chestnut and willow pollen, as well
128 as freeze-dried and microwave-dried pollen samples of both species.
129 *Microbiological analyses*. - Pollen samples submitted to different treatments were
130 used to assess standard microbiological quality parameters and safety indicators. Different
131 indicators of hygiene and contamination after processing were enumerated, i.e. aerobic
132 microorganisms, assessed on Plate Count Agar (PCA, Oxoid, Milan, Italy, based on BS EN
133 ISO 4833:2003), yeasts and moulds, assessed on Oxytetracycline Glucose Yeast Extract
134 (OGYE Agar, Oxoid, Milan, Italy, based on ISO 6611:2004), *Enterobacteriaceae*, assessed
135 on Violet Red Bile Glucose (VRBG Agar, Oxoid, Milan, Italy, based on ISO 21528-2:2004).
136 Contamination due to spore-forming bacteria was evaluated on pasteurised samples (80 °C for
137 15 min), enumerating both sulphite-reducing clostridia, assessed on Iron Sulphite Agar (ISA,
138 Oxoid, Milan, Italy, based on BS ISO 15213:2003), and aerobic sporeformers, assessed on
139 Tryptone Soya Agar (TSA, Oxoid, Milan, Italy). Coagulase-positive staphylococci, including
140 *Staphylococcus aureus* and other species, were enumerated on Bair Parker Agar (BPA,
141 Oxoid, Milan, Italy, based on ISO 6888-1:1999). Pollen samples were also used to start
142 enrichment cultures for the assessment of safety indicators, such as *Salmonella* spp. (based on
143 ISO 6579: 2002) and *Escherichia coli* (based on ISO 16654:2001) (Oxoid, Milan, Italy).
144 *Statistical analysis*. - SPSS version 23 (IBM Corp., Armonk, NY, USA) was used for
145 statistical analyses of microbial abundance expressed as Log_{10} cfu g^{-1}. Data were subjected to
146 one-way analysis of variance (ANOVA) followed by Tukey's HSD test at a 95% confidence
147 level to evaluate the effect of different pollen treatments on the abundance of microbial
148 agents. When data did not fit ANOVA assumptions, Welch robust test of equality of means or
149 Kruskal-Wallis test were performed.
150

151 RESULTS AND DISCUSSION. - *Microbial contaminants of untreated bee pollen*. - TGA
152 carried out to evaluate the water content in untreated chestnut and willow pollen showed
153 values of 14.87 % and 22.90 %, respectively. After freeze-drying for 540 min, TGA analysis
154 showed that the residual water content in chestnut and willow pollen was 6.02 % and 6.25 %,
155 respectively. After microwave-assisted drying, TGA conducted at 120 °C showed that the
156 residual water content was 6.44 % for chestnut pollen and 10.33 % for willow pollen.

157 Microbiological analyses carried out on bee-collected chestnut and willow pollen
158 showed large abundance of aerobic mesophilic microorganisms, *Enterobacteriaceae*, yeasts
159 and moulds (Tables 2-3). Values observed for the aerobic mesophilic microorganisms
160 ($F_{3,8}$=969.22) and for *Enterobacteriaceae* ($F_{3,8}$=21.26) in chestnut were significantly higher
161 than those detected in willow pollen (P<0.01). Previous studies detected low numbers of
162 coliform bacteria in untreated pollen samples (FEÁS *et al.,* 2012), whereas values ranging
163 from 4.18 to 7.67 Log cfu g^{-1} of *Enterobacteriaceae* were found in commercial pollen
164 (BELHADJ *et al.,* 2014). We support the choice of *Enterobacteriaceae* as indicator, in place of
165 coliforms, since the method used allows the detection and enumeration of both lactose-
166 fermenting and important non-lactose fermenting organisms, such as salmonellas. Previous
167 works on untreated or commercial bee pollen samples of different geographic origins reported
168 lower or similar counts, with maximum values of 5.49 Log cfu g^{-1} for aerobic microflora in
169 commercial dry samples and 5.8 Log cfu g^{-1} in untreated samples (FEÁS *et al.,* 2012;
170 NOGUEIRA *et al.,* 2012; BELHADJ *et al.,* 2012, 2014). The numbers of yeasts and moulds (8.75
171 and 8.65 Log cfu g^{-1}) in chestnut and willow pollen, respectively, were high, compared with
172 previous data (up to 6.99 Log cfu g^{-1}) obtained from commercial dry pollen (FEÁS *et al.,*
173 2012; HANI *et al.,* 2012; NOGUEIRA *et al.,* 2012; BELHADJ *et al.,* 2012, 2014). Previous
174 qualitative studies carried out on honeybee-collected pollen samples of different geographic
175 origins showed the occurrence of yeasts and moulds belonging to the genera *Candida,*

176 *Debaryomyces, Rhodotorula, Torulopsis* and *Zygosaccharomyces* (GILLIAM, 1979b; DE MELO
177 *et al.,* 2015), and *Aspergillus, Alternaria, Cladosporium, Mucor, Rhizopus, Paecilomyces* and
178 *Penicillium* (BRINDZA *et al.,* 2010; ESTEVINHO *et al.,* 2012; BELHADJ *et al.,* 2014; NARDONI *et*
179 *al.,* 2016), respectively.

180 Aerobic sporeformers showed similar low values in chestnut and willow pollen,
181 (2.02±0.30 and 2.63±0.02 Log cfu g^{-1}), while anaerobic sporeformers, assayed by sulphite-
182 reducing clostridia detection, had values of 0.44±0.22 and 1.33±0.6 Log cfu g^{-1}, respectively.
183 Our data agree with previous evaluations of Spanish pollen, which detected maximum
184 *Bacillus* counts of 1 Log cfu g^{-1}, and with data from different pollen samples, reporting the
185 absence or low counts (1 Log ufc g^{-1}) of sulphite-reducing clostridia (SERRA BONVEHÌ and
186 ESCOLÀ JORDA, 1997; ESTEVINHO *et al.,* 2012; FEÁS *et al.,* 2012; NOGUEIRA *et al.,* 2012). By
187 contrast, high levels of total anaerobes (5.77 Log cfu g^{-1}) were detected in untreated pollen
188 samples from different Algerian regions (BELHADJ *et al.,* 2012).

189 As to safety indicators, contamination due to presumptive *S. aureus,* estimated by
190 analysing coagulase-positive staphylococci, was low in chestnut and willow pollen, showing
191 values of 0.67±0.01 and 1.49±0.76 Log cfu g^{-1}, respectively, lower than those detected in both
192 untreated and commercial dry Algerian pollen samples (BELHADJ *et al.,* 2012, 2014).
193 Noteworthly, *S. aureus* was absent from Spanish and Portuguese pollen samples (NOGUEIRA
194 *et al.,* 2012). Both *Salmonella* spp. and *E. coli* were absent from all chestnut and willow
195 pollen samples analysed in this study. Previous works reported the absence of such food
196 safety indicators from pollen samples of different origins (SERRA BONVEHÌ and ESCOLÀ
197 JORDA, 1997; FEÁS *et al.,* 2012; NOGUEIRA *et al.,* 2012; BELHADJ *et al.,* 2012, 2014), except
198 for 7 out of 15 samples of commercial dry pollen analysed by BELHADJ *et al.* (2014).

199 In this work, the high microbial loads of hygiene indicators in untreated pollen did not
200 conform to the microbiological standards suggested by CAMPOS *et al.* (2008) (Table 4). On

201 the other hand, safety indicators were absent or very low. No guidelines are available for
202 sporeformer bacteria, despite the important toxigenic activities of several *Bacillus* and
203 *Clostridium* species.

204 *Impact of post-harvest conditioning on microbial hygiene and safety indicators*. -
205 Several studies highlighted that water content is the key factor for the development of
206 undesirable microorganisms in pollen for human consumption (SERRA BONVEHÌ and ESCOLÀ
207 JORDA, 1997; ESTEVINHO *et al.,* 2012). In our assays, conventional drying led to a significant
208 decrease in the abundance of aerobic mesophilic bacteria (-51%) in chestnut pollen, and it
209 reduced contamination by enterobacteria (absent in both pollen types) and yeasts in chestnut
210 (-48%) and willow (-50%) pollen (Tables 2-3). The significant reduction of enterobacteria
211 after convential drying is an important finding, as high values, ranging from 4.18 to 7.67 Log
212 cfu g^{-1}, were reported for *Enterobacteriaceae* in commercial dried pollen samples of different
213 geographic origin (BELHADJ *et al.,* 2014).

214 No impact of freeze-drying and microwave-assisted conditioning was detected on
215 hygiene indicators for pollen originating from both plant species (Tables 2-3). The only data
216 available reported inconsistent quantities for pollen samples after oven-drying or freeze-
217 drying, varying depending on sample collection season (DE MELO *et al.,* 2016).

218 None of the conditioning methods tested allowed the reduction of mould
219 contamination in chestnut and pollen samples, confirming previous data on the abundance of
220 yeasts and moulds (up to 6.99 Log cfu g^{-1}) in commercial dry pollen (FEÁS *et al.,* 2012; HANI
221 *et al.,* 2012; NOGUEIRA *et al.,* 2012; BELHADJ *et al.,* 2014). Mould contamination may
222 represent an important hazard source, since bee pollen is considered a good substrate able to
223 induce mycotoxins production (MEDINA *et al.,* 2004) and could be reduced by frequent pollen
224 collection from beehive traps and optimal storage conditions.

225 Aerobic sporeforming bacterial contamination was significantly affected by
226 microwave-based treatment of chestnut pollen (-60%), compared with the untreated control
227 ($F_{3,8}$=134.6, P<0.001), whereas such contaminants were undetectable in willow pollen
228 submitted to conventional drying. Anaerobic sporeformers analyses of conditioned pollen
229 showed that no treatments were able to reduce the abundance of sulphite-reducing clostridia
230 in samples of both botanical origin (data not shown). Indeed, the resistance of bacterial spores
231 to drying and heating is well-known, and safety concerns may be raised from the occurrence
232 of both aerobic and anaerobic sporeformers, since many species and isolates in these groups
233 are able to produce toxins, causing gastroenteritis or neuroparalytic illness. Unfortunately,
234 despite their importance for human health, no guidelines have been proposed for their control
235 in pollen.

236 Concerning the occurence of foodborne pathogenic bacteria, no changes were
237 observed in the occurrence of the safety indicators *Salmonella* spp. and *E. coli*, which were
238 absent both in control and treated pollen samples, consistently with the proposed guidelines
239 (Table 1). Coagulase-positive staphylococci were no more detectable in all treated chestnut
240 pollen samples, whereas no significant differences were detected among differentially treated
241 and control willow pollen samples, showing values ranging from undetectability (microwave-
242 assisted drying) to 1.7±0.8 Log ufc g^{-1} (freeze-drying). In a previous survey, a wide variability
243 of values has been reported for presumptive *S. aureus* contamination in commercial dried
244 pollen from different North African and Chinese regions, ranging from undetectability to a
245 maximum of 8.32 Log cfu g^{-1} (BELHADJ *et al.,* 2014). Further studies should assess coagulase-
246 positive staphylococcal contamination in European commercial pollen, although such a
247 microbial indicator is not strictly limited to pathogenic *S. aureus*.

248

249 CONCLUSIONS. **-** The present study shows that conventional drying is effective in
250 decreasing the number of microbial hygiene indicators and, for the first time, that microwave-

251 assisted conditioning affects microbial contaminants of honeybee-collected pollen for human
252 consumption. Microwave-assisted conditioning was able to strongly reduce coagulase-
253 positive staphylococci and aerobic sporeformer populations in willow and chestnut pollen,
254 respectively, compared with conventional and freeze-drying. Bee-collected pollen quality may
255 be further boosted by such a treatment, which was recently reported to preserve the content of
256 plant secondary metabolites with nutraceutical properties (CANALE *et al.,* 2016).

257 Only few countries apply microbiological criteria to commercial dehydrated bee-
258 pollen, while the International Honey Commission (IHC) has proposed guidelines including
259 limits for total aerobic microorganisms, yeasts and moulds, *Enterobacteriaceae*, *E. coli*,
260 *Salmonella* spp. and *S. aureus* (CAMPOS *et al.,* 2008). Our findings, together with those of DE-
261 MELO *et al.* (2016), reporting variable responses of bee pollen microbiota to conditioning
262 treatments, stress the importance of studies on the microbiota of bee-collected pollen for
263 human consumption, in order to process pollen with high microbiological quality, possibly
264 conforming to the proposed guidelines and to additional key indicators relevant for food
265 quality and safety.
266

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273

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370 TABLE 1. - *Microbiological standards suggested for bee-collected pollen (CAMPOS et al.,*

371 *2008).*

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Markers of	Parameter	Threshold
Microbiological quality	Total mesophilic bacteria	$<10^5$ cfu g^{-1}
	Yeasts	$<5x10^4$ cfu g^{-1}
	Fungi	$<5x10^4$ cfu g^{-1}
	Enterobacteriaceae	$<10^2$ cfu g^{-1}
Microbiological safety	*Escherichia coli*	Absent $1g^{-1}$
	Salmonella spp.	Absent $10g^{-1}$
	Staphylococcus aureus	Absent $1g^{-1}$

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376 TABLE 2. - *Impact of conventional drying, freeze-drying and microwave-assisted conditioning on microbial hygiene indicators in chestnut*
377 *pollen for human consumption. Values indicate mean Log_{10} cfu g^{-1} ± SE. In columns, different letters indicate significant differences*
378 *(ANOVA, Tukey's HSD test, P<0.05).*
379

Treatment	**Aerobic mesophilic microorganisms**	**Enterobacteria**	**Yeasts**	**Moulds**
Control	6.28±0.04 a	4.11±0.05 a	4.05±0.02 a	4.70±0.05 a
Freeze-drying	6.26±0.02 a	3.83±0.10 a	3.91±0.10 a	4.56±0.03 a
Conventional drying	3.07±0.44 b	0.00±0.00 *	2.12±0.68 b	4.08±0.08 a
Microwave-assisted conditioning	5.75±0.02 a	3.92±0.05 a	4.14±0.06 a	4.75±0.03 a
	Welch Sig. 0.001 $F_{3,4}$=106.199, P=0.001	$F_{2,6}$=4.019, P=0.078	$F_{3,8}$=7.659, P=0.01	$F_{3,8}$=37.478, P<0.001

380 * Values not included in ANOVA.

381 TABLE 3. - *Impact of conventional drying, freeze-drying and microwave-assisted conditioning on microbial hygiene indicators in willow*
382 *pollen for human consumption. Values indicate mean Log_{10} cfu g^{-1} ± SE. In columns, different letters indicate significant differences*
383 *(ANOVA, Tukey's HSD test, P<0.05).*
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Treatment	**Aerobic mesophilic microorganisms**	**Enterobacteria**	**Yeasts**	**Moulds**
Control	5.09±0.01 ab	1.09±0.65 b	4.75±0.11 a	3.90±0.10 a
Freeze-drying	5.26±0.03 a	3.36±0.27 a	4.84±0.05 a	3.85±0.05 a
Conventional drying	4.01±0.54 b	0.00±0.00 *	2.38±0.73 b	3.88±0.15 a
Microwave-assisted conditioning	5.01±0.06 ab	2.42±0.34 ab	4.71±0.02 a	3.98±0.02 a
	Welch Sig. 0.029 $F_{3,4}$=4.28, P=0.044	$F_{2,6}$=6.304, P=0.034	$F_{3,8}$=10.326, P=0.004	$F_{3,8}$=0.335, P=0.801

385 * Values not included in ANOVA.

386 TABLE 4. - *Microbiological contaminants found in untreated Italian bee-collected*
387 *pollen for human consumption. Values in bold highlighted lacking compliance to the*
388 *microbiological safety standards suggested by* C*AMPOS et al. (2008).*
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Microbial contaminants	Chestnut pollen	Willow pollen
Aerobic mesophilic bacteria	**6.28 log cfu g^{-1}±0.04**	**5.09 log cfu g^{-1}±0.01**
Enterobacteriaceae	**4.11 log cfu g^{-1}±0.05**	1.09 log cfu g^{-1}±0.65
Yeasts	4.05 log cfu g^{-1}±0.02	**4.75 log cfu g^{-1}±0.11**
Molds	4.70 log cfu g^{-1}±0.05	3.90 log cfu g^{-1}±0.10
Coagulase-positive staphylococci	**6.67 log cfu g^{-1}±0.00**	**1.49 log cfu g^{-1}±0.76**
Escherichia coli	Absent 1g^{-1}	Absent 1g^{-1}
Salmonella spp.	Absent 10 g^{-1}	Absent 10 g^{-1}

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