

Accepted Manuscript

Title: Meat handlers training in Portugal: a survey on Knowledge and Practice

Authors: Eduarda Gomes Neves, Carla Sofia Cardoso, Ana Cristina Araújo, José Manuel Correia da Costa



PII: S0956-7135(10)00328-2

DOI: [10.1016/j.foodcont.2010.09.036](https://doi.org/10.1016/j.foodcont.2010.09.036)

Reference: JFCO 2064

To appear in: *Food Control*

Received Date: 26 April 2010

Revised Date: 17 September 2010

Accepted Date: 24 September 2010

Please cite this article as: Neves, E.G., Cardoso, C.S., Araújo, A.C., Correia da Costa, M. Meat handlers training in Portugal: a survey on Knowledge and Practice, *Food Control* (2010), doi: 10.1016/j.foodcont.2010.09.036

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Eduarda Gomes Neves¹, Carla Sofia Cardoso² Ana Cristina Araújo³, and José Manuel
Correia da Costa⁴

1. Molecular Pathology and Immunology, Instituto de Ciências Biomédicas Abel Salazar (ICBAS), University of Porto, Largo Prof. Abel Salazar 2, 4050-011 Porto, Portugal

2. University of Porto, Rua dos Bragas, 223, 4050-123, Porto, Portugal

3. Direcção Geral de Veterinária, Direcção de Serviços Veterinários da Região Norte, Rua Franca 534, S. Torcato, 4800-875 Guimarães, Portugal

4. INSA National Health Institute Dr. Ricardo Jorge, Rua Alexandre Herculano, 321, 4000-055 Porto, Portugal

***Corresponding author:**

Eduarda Gomes Neves

Molecular Pathology and Immunology

Instituto de Ciências Biomédicas Abel Salazar (ICBAS)

Universidade do Porto. Lg. Prof. Abel Salazar 2, 4050-011 Porto, Portugal

Phone: +351-22-2062200

Fax: +351-22-2062232

e-mail: egomesneves@mail.icav.up.pt

Meat handlers training in Portugal: a survey on Knowledge and Practice

Abstract

Professional training for meat handlers is an European Community food law requirement in order to apply HACCP principles and achieve food safety goals. A self-administered questionnaire designed to assess “Knowledge” and “Practice” of public hygiene measures was completed by meat handlers (MH) (n=159) in slaughterhouses in Portugal. A significant proportion of the group

(72.7%) has had professional training in two different areas: Good Practice in Food Industry (12.03%) and Work Safety and Hygiene (22.8%); 37.9% of the respondents have had training in both areas. However 24.5% of the subjects have never had training. Meat handlers with professional training in Good Practice in Food Industry (GPFI) and in both areas (BT) have had the highest proportions of correct answers in Knowledge (66.92 ± 16.36 and 67.26 ± 21.05 , respectively) and Practice questions (70.53 ± 17.47 and 68.67 ± 22.58 , respectively).

The results of this study point to the need to improve training, particularly in Good Practice in Food Industry, thus enabling meat handlers to achieve more correct answers in Knowledge and Practice. The development of evaluation criteria for the effectiveness of professional training is crucial to protect Public Health.

Key Words: Hygiene, Training, Meat handlers, Knowledge, Practice, Portugal.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

Meat handlers training in Portugal: a survey on Knowledge and Practice

Abstract

Professional training for meat handlers is an European Community food law requirement in order to apply HACCP principles and achieve food safety goals. A self-administered questionnaire designed to assess “Knowledge” and “Practice” of public hygiene measures was completed by meat handlers (MH) (n=159) in slaughterhouses in Portugal. A significant proportion of the group (72.7%) has had professional training in two different areas: Good Practice in Food Industry (12.03%) and Work Safety and Hygiene (22.8%); 37.9% of the respondents have had training in both areas. However 24.5% of the subjects have never had training. Meat handlers with professional training in Good Practice in Food Industry (GPFI) and in both areas (BT) have had the highest proportions of correct answers in Knowledge (66.92±16.36 and 67.26±21.05, respectively) and Practice questions (70.53±17.47 and 68.67±22.58, respectively).

The results of this study point to the need to improve training, particularly in Good Practice in Food Industry, thus enabling meat handlers to achieve more correct answers in Knowledge and Practice. The development of evaluation criteria for the effectiveness of professional training is crucial to protect Public Health.

Key Words: Hygiene, Training, Meat handlers, Knowledge, Practice, Portugal.

26 **1. Introduction**

27 The increasing incidence of food borne diseases has been assigned to many
28 different factors, including population growth, changes in food preparation habits, a
29 rise in the number of food-service establishments, increased consumption of food
30 outside the home and a lack of food safety training and education among
31 consumers and food handlers (Motarjemi & Käferstein, 1999). Worker mishandling
32 of food is one of the major causes of food borne disease outbreaks (WHO, 2000).
33 Because outbreaks often lead to severe economic losses, food handler training is an
34 important business strategy for managing food safety risks. Moreover, food handler
35 training is seen as one strategy by which food safety can be increased, offering
36 long-term benefits for the food industry (Smith, 1994). In addition, the European
37 Parliament has adopted in April 2004 the Regulation (EU) No. 852/2004, underlining
38 the need for all the food businesses to identify the steps of the production process in
39 order to ensure food safety and this has been applied to all EU food businesses
40 since the 1st January 2006. The main change relates to food safety management
41 systems, i.e. risk-based methodologies to ensure food safety. The law's
42 implementation recognizes education of food handlers as a crucial line of defence in
43 the prevention of food borne illnesses (Sun & Ockerman, 2005; Legnani, Leoni,
44 Berveglieri, Mirolo, & Alvaro, 2004; Worsfold, 2001; Martínez-Tomé, Vera & Murcia,
45 2000). Food business operators shall ensure that all stages of production,
46 processing and distribution of food under their control satisfy the relevant hygiene
47 requirements laid down in the Regulation (EU) No. 852/2004 (Jevšnik, Hlebec &
48 Raspor, 2008). A successful implementation of the procedures based on the
49 HACCP (Hazard Analysis and Critical Control Points) principles will require the full
50 cooperation and commitment of food business employees and to this end they
51 should undergo training. Under the personal program of HACCP, employees must
52 be trained in such areas as food safety, manufacturing controls and personnel

53 hygiene. Once HACCP plans have been established, employees must be trained to
54 manage any critical control points (CCPs). The necessity of application of the
55 HACCP principles introduced by the *Codex Alimentarius* 30 years ago became law
56 in Portugal in 1998 (Diário da República, 1998), and the Portuguese law has
57 recently established the requisites for a “handler card” (Diário da República, 2006)
58 for meat handlers (MH) working in meat retail businesses, to apply from 1st August
59 2008. To obtain this card, it is necessary to attend 15 hours of mandatory training on
60 the following subjects: Meat Hygiene, Food Microbiology, Handlers' Personal
61 Hygiene, Working spaces and Equipments' Hygiene, Packaging of meat and meat
62 products, Hygiene of meat selling and delivery, Food Safety and HACCP, Work
63 Safety and Hygiene. However, this training and this card are not required for
64 working in abattoirs and deboning rooms, where it is considered that the EU
65 regulations No. 852/2004 and No. 853/2004 regulate the need for professional
66 training. The Portuguese general law that regulates work conditions has a legal
67 requirement of 35 hours of yearly training for all workers (Diário da República, 2003,
68 2004). Recently, much has been written specifically on training in the food industry,
69 but a great part of it is rather specific in nature and has been limited to discussions
70 on single segments, primarily hotels and restaurants (Barrows, 2000; Seaman &
71 Eves, 2006). There is a general lack of information about professional training for
72 slaughterhouses and deboning rooms' workers.

73 The aim of this study was to evaluate and compare the level of general knowledge
74 and practice of meat handlers from slaughterhouses and meat plants from northern
75 Portugal, evaluating the professional training they have received. To our knowledge,
76 this is the first survey on meat handling knowledge and practice in Portugal. Other
77 similar studies have been reported in several countries focusing on food handlers
78 (Walker, Pritchard & Forsythe, 2003; Nel, Lues, Buys & Venter, 2004; Seaman &

79 Eves, 2006; Gomes-Neves, Araújo, Ramos & Cardoso, 2007; Jevšnik, Hlebec &
80 Raspor, 2008).

ACCEPTED MANUSCRIPT

81 2. Material and Methods

82 2.1. Questionnaire design

83 The self-administered questionnaire used in this study comprises 24 multiple
84 choice questions with three or four possible answers, including “do not know” for the
85 purpose of minimizing the possibility of selecting the correct answer by chance. In
86 addition, the questionnaire has seven questions related to demographic and job
87 characteristics of the respondents (age, gender, number of years of formal
88 education, age at the beginning of professional activity, job description and years of
89 experience in the present activity and present company, professional training and
90 the opinion to additional training). The present questionnaire has been adapted from
91 a questionnaire used in a previous study (Gomes-Neves et al, 2007).

92 The questions were designed and structured in two groups. A group of
93 questions designated “Knowledge” (14 questions) was intended to assess the
94 respondent’s knowledge about HACCP, microbiologic hazards development, food
95 poisoning and food borne illness, safety and health requirements, high-risk food
96 groups, dirty and clean areas in the workspace and water temperature in knife
97 sterilizers. A second group of questions designated “Practice” (10 questions) was
98 designed to assess respondents' habits focused on personal hygiene practice and
99 cross contamination, working surfaces and instrument washing requirements and
100 products, meat and chopped meat storage temperatures, freezing temperatures,
101 temperature ranges and food poisoning agents development, water treatment and
102 non potable water use, as water supply and quality and food security and safety are
103 intertwined (Kirby, Bartram & Carr, 2003)(Table 1).

104 The participants answering the questionnaire have remained anonymous.
105 Each participant has been informed of the purpose of the survey and that
106 confidentiality would be assured.

107

108 2.2. Questionnaire delivery

109 The questionnaire has been delivered in person in seven red meat abattoirs with
110 deboning rooms, during routine meat inspection of the Veterinary Official Services
111 between May 2007 and May 2008, in two different regions of northern Portugal. In
112 each meat plant, questionnaires have been delivered to all the employees
113 performing tasks related with meat handling. The completed questionnaires have
114 been collected in person one month later.

115 2.3. Statistical analysis

116 The analysis of the questionnaires has been performed using the computer software
117 SPSS® (SPSS Inc., Chicago, IL; version 17.0). The significance of the statistical
118 differences of the proportion of correct answers between the groups of participants
119 classified according to professional training has been identified using the Chi-
120 Square test. The 95% confidence intervals (95% CI) of the proportion of correct
121 answers in each group have been estimated according to the Wilson procedure with
122 a correction for continuity (Wilson, 1927; Newcombe, 1998). The differences in the
123 mean scores of Knowledge and Practice questions between the same groups
124 referred to above have been determined using one-way ANOVA with a post-hoc
125 test. In all tests, the statistical significance was two-sided and considered significant
126 at $p < 0.05$.

127 **3. Results**

128 3.1. Quantitative results

129 3.1.1. Participants' response

130 Answers have been obtained from all the meat plants contacted, but 10% of the
131 employees have not returned the questionnaire. The number of participants was 159
132 (115 male and 44 female). All but one were Portuguese. The participants' general
133 characteristics are presented in Table 2.

134

135 3.1.2. Comparative analysis of training areas and periods of time among participants

136 Two different areas of professional training among meat handlers (MH) have been
137 identified: 1. Good practice in food industry (GPFI), and 2. Work Safety and Hygiene
138 (WSH). The vast majority of the respondents (72.7%) has had professional training.
139 Twelve percent (12.03%) of the respondents have had training in GPFI (12.03%),
140 22.8% in WSH and 37.9% in both areas (BT). During the previous year, 37.7% of
141 the MH have received between 20 and 35 hours of training, but 24.7% have never
142 attended professional training (NT). Eighteen percent have had more than 35 hours
143 of training. For comparison purposes, respondents were divided in four professional
144 training groups: GPFI, WSH, BT (both training) and NT (no training). Fifty percent
145 (50.3%) of MH with professional training think that training provides useful
146 information to their work and 64.9% are interested in future training and consider it
147 very important.

148 3.1.3. Comparative analysis of response to “Knowledge” and “Practice” questions

149 The group of respondents that has had training in the two areas (BT) reached the
150 highest mean score of proportion of correct answers in the group “Knowledge”
151 (67.26 ± 21.05), followed by the GPFI with a mean score of 66.92 ± 16.36 correct
152 answers; WSH had 49.21 ± 22.77 and NT 47.89 ± 22.63 .

153 In the group of questions “Practice”, GPFI has had the highest proportion of correct
154 answers with a mean score of 70.53 ± 17.47 , followed by BT (68.67 ± 22.58). The
155 mean score of correct answers for WSH has been of 58.33 ± 19.93 , and for NT
156 63.44 ± 21.70 . The difference between the proportion of correct answers to the
157 questions “Knowledge” and “Practice” is statistically significant between the groups
158 (one-way ANOVA Table 3). For the group of questions “Knowledge”, a post-hoc test
159 (Tukey HSD test) has defined two different homogenous groups, one with the

160 respondents that have attended GPFI or both areas of professional training and the
161 other with the respondents that have had WSH or no training. In the group of
162 questions "Practice", the same test has assumed two different groups, GPFI and
163 NT. The other two groups (WSH and BT) could not be discriminated. This analysis
164 underlines the fact that, for the questionnaire content and for the purpose of food
165 safety improvement, WSH professional training has no positive impact.

166 3.2. Qualitative results

167 It has been considered important to detect finer differences among the answers to
168 questions that tested the quality of the information sought (Tables 4A and 4B).

169 3.2.1. "Knowledge" Questions (Table 4A)

170 *HACCP*

171 Regarding HACCP, 29.3% of MH have never heard of the term and 7% are
172 acquainted with the expression but do not know the meaning of it. Regarding
173 training, from the WSH group, 55.6% answered "do not know" to the question "What
174 is HACCP?" and that proportion increases to 66.7% in the NT group. The proportion
175 of respondents who have given correct answers has been of 63.2% in the GPFI
176 group and 51.7% in the BT group. This group has also had the highest proportion of
177 incorrect answers: 31.7% (NT: 15.4%, WSH: 22.2% and GPFS:15,8%). These
178 differences were statistically significant ($p=0.000$ using Pearson Chi-Square test).

179 *Food Poisoning and Food Borne Illness*

180 Almost the half (47.4%) of GPFI, 58.3% of WSH, 53.3% of BT and 43.6% of NT
181 believe that they can identify whether meat is contaminated with food poisoning
182 bacteria by visual, olfactory or taste checks ($p=0.368$, using Pearson Chi-Square
183 test). Similar results have been obtained in other surveys among food handlers
184 (Walker et al, 2003; Gomes-Neves et al, 2007; Jevšnik et al, 2008) The majority of

185 the MH (60.1%) are aware that insects, other food handlers and raw food are
186 sources of bacteria, but 26.3 % of GPFI, 44.4% of WSH, 15% of BT and 33.3% think
187 that MH can only contaminate meat if they are ill ($p=0.001$, using Pearson Chi-
188 Square test). Twenty six percent (26.3%) of GPFI, 30.6% of WSH, 11.7% of BT and
189 41.0% of NT believe that MH can only get sick if they have contact with animal blood
190 during work activity ($p=0.000$, using Pearson Chi-Square test). A significant majority
191 of MH knows that diarrhoea is the symptom that is most associated with food borne
192 illness (85.3%) but 33.3% of NT, 30.6% of WSH and 11.7% of BT have not been
193 able to identify consequences of intestinal bacterial infection (*E. coli*, *Salmonella*,
194 *Campylobacter* and *Yersinia*). These differences among groups of respondents
195 were statistically significant ($p=0.001$, using Pearson Chi-Square test). Sixty two
196 percent (61.5%) of NT have answered “do not know” to the question that relates
197 *Listeria monocytogenes* with food borne illness and 55.6% of WSH, 38.3% of BT
198 and 26.3% of GPFI have given the same answer. Sixteen (16.0%) percent of all MH
199 knew the name of the bacteria but did not identify the disease or transmission paths
200 ($p=0.108$, using Pearson Chi-Square test).

201 *Temperature and Food Poisoning Agent's Inactivation*

202 Twenty percent of WSH (19.5) and NT (20.4) have answered “do not know” to the
203 question “What happens to bacteria at 37°C?”. More than a half (52.6%) of GPFI,
204 41.7% of WSH, 51.7% of BT and 28.2% of NT think that pasteurised milk is a sterile
205 product. Among the NT group, 43.6% have not answered the question “identify a
206 sterile food product” ($p=0.105$, using Pearson Chi-Square test). High temperature
207 has been recognised as a safe method to destroy bacteria by 52.6% of GPFI, 50.0%
208 of WSH, 56.7% of BT and 48.7% of NT but 24.4% of MH think that refrigeration also
209 kills bacteria. The majority (64.6%) of MH knows that 82 °C is the correct
210 temperature for the water in sterilisers for knives and steels in stations located along
211 the slaughter floors (Eustace *et al*, 2007), but 21.1% of GPFI, 38.9% of WSH, 30.0%

212 of BT and 28.2% of NT have not answered correctly. The differences between the
213 groups of respondents were not statistically significant.

214 *Safety and Health Requirements*

215 Many MH did not seem to be aware of basic safety and health requirements to work
216 with food. A majority of GPFI, WSH and NT (52.6%, 52.8% and 51.3%, respectively)
217 have not identified skin disease, gastrointestinal disturbances, eye/ear and throat
218 disease as conditions that are not acceptable in meat handling. Only 28.3% of BT
219 ignored these conditions. Thirty four percent of the MH answered that only a skin
220 disease is a non acceptable condition for meat handling. Sixty eight percent (67.5%)
221 of the MH were aware of the need for skin injury protection in meat handling
222 ($p=0.009$, using Pearson Chi-Square test).

223 According to Jacob (1989), routine medical examinations of food handlers are of
224 little value because they merely reveal the health status of the worker at a specific
225 point in time. The author further states that these medical examinations are
226 unreliable and that carriers of pathogens are unlikely to transmit these organisms. In
227 this study, 72.4% of the respondents have indicated that they have been to routine
228 medical examinations during the previous year, while 5.9% indicated that they have
229 gone because they felt sick, whereas 12.5% needed to undergo medical
230 examinations before employment. Food handlers must undergo medical
231 examinations before employment to assess the general health. However, it has
232 been suggested that routine medical examinations are regarded as not being cost-
233 effective and, in fact, unreliable (Jacob, 1989; Nel *et al* 2004).

234 *Dirty and Clean Workspaces at the Abattoir*

235 Sixteen percent (15.8%) of GPFI, 44.4% of WSH, 20.0% of BT and 35.9% of NT
236 have identified incorrectly all the dirty areas in the abattoir. Of all MH, 10% think that

237 only the lairage is a dirty space, and 18% have only identified the room where offal
238 are washed and prepared ($p=0.001$, using Pearson Chi-Square test)..

239 3.2.2. "Practice" Questions (Table 4B)

240 *Instruments and Working Surface Cleaning*

241 Eighty nine percent (88.5%) of the respondents were aware of the working surfaces
242 and instruments washing and disinfection routine and correct steps and only 5.7%
243 answered that they did not have contact with that operation. As far as disinfection is
244 concerned, 25.3% of MH thought that sodium hypochlorite is the best disinfectant in
245 meat industry but 47.4% were aware of the need for regular rotation of products for
246 this purpose (Meyer, 2006). However, 12% did not know that, after the use of
247 disinfectant on instruments and surfaces, both of them must be cleaned with potable
248 water. Forty two percent (42.1%) of GPFI, 25.0% of WSH, 31.7% of BT and 30.8%
249 of NT thought that non-potable water could be used for the cleaning of working
250 surfaces and instruments. These differences were not statistically significant.

251 *Personal Hygiene*

252 To the question "When do you wash your hands during a work day" only 3.2% of MH
253 have not answered and 89.2% have answered that they washes them several times
254 and whenever the activity is interrupted ($p=0.181$, using Pearson Chi-Square test).
255 To the question "different steps to correct hand wash", 5.8% of MH have not
256 answered. The majority of MH referred all the steps for a correct hand wash,
257 however 21.1% of GPFI, 38.9% of WSH, 30.0% of BT and 43.6% of NT have
258 answered incorrectly, because they have not mentioned the use of nail brush
259 ($p=0.015$, using Pearson Chi-Square test).

260 *Temperature Control*

261 From the three ranges of temperatures presented, 0-4 °C/5-65 °C/70-80 °C, only
262 32.3% of the MH identified the range of 5-65°C as the high-risk meat storing
263 temperature. The GPFI group has also had the highest proportion of incorrect
264 answers (63.2%), followed by BT (53.3%), WSH (52.8%) and NT (51.3%).
265 Interestingly, the GPFI group seems to be confident regarding this topic since none
266 of the respondents report “do not know” to this question, although the majority of the
267 subjects has answered incorrectly. Seventy eight percent (77.8%) knew of the
268 correct red meat storage temperature but only half of MH have reported the correct
269 freezing temperature (50.6%) and the correct storage temperature for chopped meat
270 (51.3%). If we consider professional training, WSH group has had a lower proportion
271 of correct answers on red meat storage temperature (63.9%) than NT (74.4%).
272 Twenty six percent (26.3%) of GPFI, 44.4% of WSH, 30.0% of BT and 23.1% of NT
273 have answered incorrectly to the question about chopped meat storage temperature
274 and 33.3% of NT answered “do not know” ($p=0.036$, using Pearson Chi-Square
275 test).

276 *Change of Clothes and Instruments and Cross-contamination Sources*

277 Only twenty one percent (21.1%) of the GPFI, 27.8% of the WSH, 31.7% of BT and
278 33.3% of NT recognise the need to change clothes and knives by the end of the
279 work at the abattoir (mainly in the first hours of the day), when they continue their
280 tasks in the deboning room of the same building ($p=0.087$, using Pearson Chi-
281 Square test). Fifty seven percent (56.8%) of all MH change their protective clothing
282 but do not replace knives and 5.8% carry their clothes and knives from the slaughter
283 room into the deboning room. Regarding the porosity of surfaces, it can be observed
284 that porous surfaces (clothes, aprons, sponges, etc.) show lower transfer rates
285 when compared to non-porous surfaces as stainless steel and knobs (Scott &
286 Bloomfield, 1990; Kusumaningrum, Van Putten, Rombouts & Beumer, 2002).
287 However, in this case, although apparently a lower risk might be associated to

288 transfer from fabrics, it should be noted that the residual water (and eventually
289 blood) accumulated in clothes would enable bacteria to survive for longer periods
290 and, consequently, bacterial transfer events could also be prolonged (Bloomfield,
291 Arthur, Van Klingerren, Holah, Pullen & Elton,1994; Eustace, Midgley, Giarrusso,
292 Laurent, Jenson & Sumner, 2007; Rusin , Maxwell & Gerba , 2002).

293 In addition to protective clothing fulfilling a safety function, 44.7% wear stainless
294 steel mesh gloves. Stainless steel gloves also require cleaning and sterilisation, but
295 these gloves are difficult to clean, due to their woven construction (Van Zyl, 1998).
296 Upon asking the respondents about the frequency of cleaning, 59.5% have reported
297 that they wash and sterilise their gloves several times a day, whenever they are
298 visibly dirty (usually full of fatty or bloody deposits). Furthermore, a small
299 percentage, 11.1% sterilises their gloves on a daily basis (end of work), while 22.2%
300 have answered they never washed or sterilised their gloves because they were not
301 connected with cleaning tasks. According to the Canadian Food Inspection Agency
302 (CFIA), these gloves should be sterilised at regular intervals throughout the working
303 shifts to prevent cross-contamination between gloves and meat (CFIA, 1990; Nel *et*
304 *al*, 2004).

305 On the matter of Pre-Requisite Plans (PRP) participation, 56.6% did not participate
306 in any activity. The highest participation is related with cleaning activity, since 17.8%
307 complete cleaning checklist forms and only 9.2% participate in meat temperature
308 control activities, whereas 8.6% have maintenance related tasks.

309 **4. Discussion**

310 The questionnaire designed for the present study has allowed to detect quantitative
311 differences in “knowledge” and “practice” skills among the participants. The
312 satisfactory participation has permitted to highlight the existence of differences
313 between MH who have and have not received professional training, obtaining the

314 groups NT, WSH, GPFI and BT. This is remarkable and somewhat reassuring.
315 Nevertheless, a further finer analysis of the content of the questions themselves
316 (qualitative results) has not led to the same sense of reassurance. The proportion of
317 correct answers in the MH groups who have had GPFI or BT training is significantly
318 higher than the others from a statistical point of view, but results have also indicated
319 that WSH training is not relevant to Food Hygiene and Food Safety knowledge and
320 practice.

321 Regarding HACCP, which is a recent and relevant imposition of the EU Food Law,
322 there was still a high proportion of MH (even with professional training, the WSH
323 group) who were unacquainted with the concept. To the question "What is HACCP",
324 only half of BT have answered correctly and this group has also had the highest
325 proportion of incorrect answers, somehow contrary to what should be expected. It
326 seems to be very difficult to implement an HACCP based system in this industry,
327 when a high proportion of employees is not familiar with this reality and does not
328 participate in PRP. Mortimore and Smith (1998) have shown that many trainers had
329 been willing to provide HACCP training without considering the scope (what has to
330 be taught and what need not) and the depth of coverage. Although numerous
331 companies have developed, documented and implemented training programs, few
332 understand why employee training is important, what their training requirements are,
333 or how to assess the effectiveness of in-house training programs.

334 In the matter of meat storage temperatures, e.g. red meat, the WSH group has had
335 the highest rate of incorrect answers and the lowest of correct answers. The BT
336 group has not had better results, regarding the fact that they associate two different
337 areas of professional training. A high proportion of GPFI, WSH and BT rely on
338 visual, olfactory or taste checks to identify bacteria contaminated meat. This finding
339 is difficult to explain, considering that they all have had professional training. The
340 study demonstrates that there is also a general lack of knowledge on microbiological

341 food hazards, i.e. *E. coli*, *Salmonella*, *Campylobacter*, *Yersinia* and *Listeria*
342 *monocytogenes*.

343 It is generally accepted that the hands of food handlers are an important vehicle of
344 food cross-contamination and that improved personal hygiene and scrupulous hand
345 washing lead to the basic control of spread of potentially pathogenic transient
346 microorganisms (Allwood, Jenkins, Paulus, Johnson, & Hedberg, 2004; Daniels,
347 MacKinnon, Rowe, Bean, Griffin, & Mead, 2002; Fry, Braden, Griffin, & Hughes,
348 2005; Lues & Van Tonder, 2007; Sneed, Strohbehn, Gilmore, & Mendonca, 2004).
349 In this study, it has been possible to observe that in the four groups there are
350 respondents who do not know all the steps for a correct hand wash. According to
351 the results of Shojaei *et al* (2006), a dramatic reduction in hand contamination has
352 been observed after a simple intervention that included a face-to-face health
353 education on strict hand washing after visiting the toilet.

354 Concerning the topic of cross contamination, the majority of MH does not seem to
355 be aware of the importance of changing clothes and working instruments, when they
356 move from the tasks developed in “dirty spaces” (located at the abattoir) to “clean
357 spaces” (deboning room). In addition, they also seem to have difficulties in
358 identifying the differences between the spaces themselves. The UK surveillance
359 system has reported that cross contamination was the main contributing factor
360 (32%) for the outbreaks investigated in the period of 1999-2000 (WHO, 2003).
361 Similarly, the US Centres for Disease Control and Prevention (CDC) have reported
362 that 18 and 19% of food borne diseases caused by bacteria in the years 1993 and
363 1997 in the United States were associated with contaminated equipment and poor
364 hygiene practices, respectively (CDC, 2000). Moreover, although most outbreaks
365 result from extensive growth at abusive storage temperatures, insufficient cooking,
366 etc., many are also associated with bacterial cross contamination/recontamination
367 (Notermans, Zwietering & Mead, 1994; Roberts, 1990). Similarly, various authors

368 have stated that cross contamination of bacterial and viral pathogens in homes and
369 in food-service establishments could well be the major contributing factor to sporadic
370 and epidemic food borne illnesses (Beumer & Kusumaningrum, 2003; Bloomfield,
371 2003; Chen, Jackson, Chea, & Schaffner, 2001). In the present study, a high
372 proportion of respondents admits a potentially dangerous behaviour on a daily basis
373 without supervisory support, as 56.8% (n=88) change their knives but do not change
374 clothes when they end the work at the abattoir and start at the deboning room. In a
375 HACCP based system perspective this is an unacceptable occurrence.

376 As a result of EU law implementation, Portuguese slaughterhouse and deboning
377 room owners need to offer professional training to their employees but they do not
378 show special concerns about their own training program and its contents. According
379 to the evaluation of the present study, in a high proportion of MH who have had
380 professional training in WSH, this training has not produced a significant contribution
381 to meat safety. Furthermore, as several authors suggested, it seems that most
382 managers in food and meat industry have a limited understanding of the global food
383 safety strategy (Ehiri, Morris, & McEwen, 1997; Mortimore & Smith, 1998; Khandke
384 & Mayes, 1998; Williams, Smith, Gaze, Mortimore, Motarjemi, & Wallace, 2003).
385 MacAuslan (2003) has pointed out that the majority of food businesses do not have
386 satisfactory training policies for all their staff. The author emphasized that too much
387 reliance is being placed upon attaining a training certificate rather than attention paid
388 to achieving competency in food hygiene practice. More emphasis and resources
389 need to be diverted towards assisting managers to become highly motivated to food
390 hygiene managers who develop and maintain a food safety background within their
391 business. Few employers perceive a relationship between investment in their human
392 resource assets and successful business performance, and training is often
393 undertaken only to meet perceived statutory or inspection requirements (Pratten &
394 Curtis, 2002; Seaman & Eves, 2006). Food business owners may be tempted to

395 place the burden of training responsibility on an external employer, and not shoulder
396 any responsibility themselves. This problem has two sides; firstly the employer lacks
397 key management skills in leadership, motivation, training and evaluation, and
398 secondly going for a certificate course as it is the “done thing” (MacAuslan, 2003).
399 What we have observed in the present study is that the pressure to accomplish the
400 law leads employers to get specialised training for their employees; however, there
401 is no evidence that the worker practices improve when training programs provide
402 only information (Nieto-Montenegro, Brown & LaBorde LF ,2008; Rennie, 1994).
403 Several studies have demonstrated that increasing knowledge does not necessarily
404 lead to changes in behaviours (Clayton, Griffith, Price, & Peters, 2002; Ehiri *et al*,
405 1997; Rennie, 1994, 1995). To be effective, training programs should be based on
406 appropriate adult education theory (Rhodes, 1988). In the present study, we have
407 verified a low educational level of MH, the average formal education years being 6.5
408 (in Portugal the mandatory formal education takes 12 years) in a group with a mean
409 age of 35 (Table 2), which may be a possible explanation factor for our results. The
410 findings in the study of Toh and Birchenough (2000) affirmed education as an
411 important link to the two variables: knowledge and attitudes; customs and
412 environment. Some other authors suggest that the training programs should
413 incorporate activities that support skills development relevant to real life situations in
414 which the workers can put information into practice (Edmunds, Lowe, Murray &
415 Seymour,1999; Kowalski & Vaught, 2002). Food hygiene training is a legal
416 requirement within food industry and should be only one part of an effective food
417 safety management strategy. Training will only lead to an improvement in food
418 safety if the knowledge imparted leads to desired changes in behaviour at the
419 workplace (Nieto-Montenegro, Brown & LaBorde, 2008; Seaman & Eves, 2006).
420 Professional training of MH in Portugal has been “classroom based” and this study
421 aims to contribute to a reflexion on the need for evaluation towards practical
422 improvements.

423 Evidence from the literature suggests that food hygiene training as a mean of
424 improving food safety standards is limited by a lack of understanding of those
425 factors contributing to successful outcomes. Training activities closely associated
426 with work environment would be more appropriate than food hygiene courses that
427 operate divorced from the workplace and use solely knowledge-based assessment
428 techniques (Seaman & Eves, 2006). The training of managers is a necessary
429 precursor to the implementation of realistic food safety practices within the
430 workplace. The effectiveness of training is very dependent on both management
431 attitude and their willingness to provide the resources and systems for food handlers
432 to implement good practices. There is a need to develop training methods that
433 proved to change behaviour as well as imparting knowledge (Egan *et al*, 2007).
434 Further research in issues including course content, training location, duration of
435 courses, motivational factors and refreshment training is needed. Such research
436 needs to be clearly thought out, well designed with good baseline data to achieve
437 worthwhile results (Egan *et al*, 2007; Seaman & Eves, 2006). Seaman (2010)
438 proposes the *Food Hygiene Training Model* which includes evaluation stages,
439 managerial components and overall performance measures to take into account
440 both the effective planning of the training program, the managerial support required
441 to facilitate the training process, and the overall performance measures needed to
442 ensure that training transfers into the required safe food handling behaviours. The
443 proposed model incorporates three evaluation stages of the food handlers: 1)
444 documented training needs with individual record, establishing a starting point; 2)
445 knowledge test and/or practical skill assessment shortly after training, assessing any
446 deficiencies in skills or knowledge at this stage; 3) food handlers evaluation of the
447 training program to measure the perceived value and relevance of the training
448 program, allowing respondents to portray approval or disapproval towards certain
449 aspects of the training (Seaman, 2010). The overall performance measures include
450 two final evaluation categories: the effect of food hygiene training on the individual

451 food handler and the effect on the organization (Seaman, 2010). The success of
452 training relies on the choice of the program, considering the relevance of the course
453 to work activities, and providing food hygiene training in a language and at a level
454 that allows the food handler to understand the content (Seaman,2010; Rennie,
455 1994). Authors suggest that food hygiene courses should be shorter and focused on
456 the needs and motivation of the participant, and include refresher training to provide
457 both a physical and psychological environment conducive to food handler
458 development and the enactment of safe food handling practices (MacAuslan, 2001;
459 Rennie, 1994; Seaman, 2010; Worsfold, 2004).

460 The significance of the present results is limited in part by the sample size and by
461 the fact that it has based on self-reported behaviour and practice. It is possible to
462 conclude, however, that EU regulations have had a positive outcome in the matter of
463 professional training of MH in Portugal. Operators, however, cannot rely on the fact
464 that training has ever taken place. They must assume that all employees will need
465 thorough, repeated training in the area of food hygiene and safety, as we observed
466 that WSH training is not relevant to this aim (in spite of being relevant in terms of
467 occupational safety and health). We suggest what can be a major concern in the
468 moment of hiring new employees: to assess knowledge in food safety and promote
469 immediate professional training, in addition to asking about previous work
470 experience. In the present study, the MH show an average of 12.6 years of
471 experience in the activity. However, the respondents have had poor results on the
472 HACCP, microbiological hazards, temperature control, personal hygiene and cross-
473 contamination subjects .

474 In this activity, characterized by hard physical work and a traditionally low
475 educational level of the workers, professional training should be adapted, with a
476 strong connection knowledge-practice, considering motivational factors and beliefs.

477 Behaviour changes in MH should be evaluated according to those conditions,
478 encouraging the learning process and rewarding practical improvements.

479

480 **Acknowledgments**

481 We gratefully acknowledge to Prof. Fátima Gärtner and Prof. Margarida Fonseca
482 Cardoso for their comments and help in the preparation of the manuscript and Dr.
483 Ana Isabel Oliveira for her cooperation on questionnaire delivery.

484

485

486

487

488

489

490

491

492

493

494

495

496

497

498 **References**

- 499 Allwood, P. B., Jenkins, T., Paulus, C., Johnson, L., & Hedberg, C. W. (2004).
500 Hand washing compliance among retail food establishment workers in
501 Minnesota. *Journal of Food Protection*, 67(12), 2825–2828.
- 502 Barrows, C.W. (2000) An exploratory study of food and beverage training in
503 private clubs, *International Journal of Contemporary Hospitality* 12 (3), 190–
504 197.
- 505 Beumer, R. R., & Kusumaningrum, H. (2003). Kitchen hygiene in daily life.
506 *International Biodeterioration & Biodegradation*, 51, 299-302.
- 507 Bloomfield, S. F., Arthur, M., Van Klingerren, B., Holah, J. T., Pullen,W. & Elton,
508 R. (1994). An evaluation of the repeatability and reproducibility of a surface
509 test for the activity of disinfectants. *Journal of Applied Bacteriology*, 76, 86-
510 94.
- 511 Bloomfield, S. F. (2003). Home hygiene: a risk approach. *International*
512 *Journal of Hygiene and Environmental Health*, 206, 1-8.
- 513 CDC (Center for Disease Control and Prevention) (2000). Surveillance for
514 Foodborne Disease Outbreaks e United States, 1993e1997. Available from
515 <http://www.cdc.gov/>
- 516 Canadian Food Inspection Agency. (1990). Meat hygiene manual of procedures,
517 Canada. Available: www.inspection.gc.ca Accessed2002-03-26
- 518 Clayton, D. A., Griffith, C. J., Price, P., & Peters, A. C. (2002). Foodhandlers'
519 beliefs and self-reported practices. *International Journal of Environmental*
520 *Health Research*, 12(1), 25–29.
- 521 Chen, Y., Jackson, K. M., Chea, F. P., & Schaffner, D. W. (2001). Quantification
522 and variability analysis of bacterial cross-contamination rates in common
523 food service tasks. *Journal of Food Protection*, 64, 72-80.

- 524 Daniels, N. A., MacKinnon, L., Rowe, S. M., Bean, N. H., Griffin, P. M., & Mead,
525 P. S. (2002). Food borne disease outbreaks in United States schools. *The*
526 *Pediatric Infectious Disease Journal*, 21(7), 623–628
- 527 Diário da República (1998). 1ª série A, Nº 65. Decreto-Lei no. 67/98 de 18 de
528 Março. Diário da República I, Série A, no. 65.
- 529 Diário da República (2003) 1ª série A, Nº197, Lei nº99/2003 de 27 de Agosto.
530 Aprova o Código do Trabalho. Diário da República, 1ª série A,197,5558-5675
- 531 Diário da República (2004) 1ª série A, Nº177,Lei Nº35/2004 de 29 de Julho.
532 Regulamenta a Lei Nº99/2003. 1ª série A,177,4810-4885
- 533 Diário da República (2006) 1ª série Nº146 Dec-lei 147/2006 31 Julho 2006..
534 Diário da República, 1ª série,146, 5442-5451
- 535 Edmunds, C., Lowe, K., Murray, M., & Seymour, A. (1999). The ultimate
536 educator: achieving maximum adult learning through training and instruction.
537 OfficeforVictimsofCrime.WebsiteAddress:[http://www.ojp.usdoj.gov/ovc/assist/](http://www.ojp.usdoj.gov/ovc/assist/educator/welcome.html)
538 [educator/welcome.html](http://www.ojp.usdoj.gov/ovc/assist/educator/welcome.html).
- 539 Egan M. B, Raats M.M. , Grubb S.M. , Eves, A. , Lumbers, M.L., Dean, M.S. ,
540 Adams M.R. (2007) A review of food safety and food hygiene training studies
541 in the commercial sector. *Food Control*, 18, 1180-1190
- 542 Ehiri, J. E., Morris, G. P., & McEwen, J. (1997). Evaluation of a food hygiene
543 training course in Scotland. *Food Control*, 8(3), 137–147.
- 544 Eustace, Ian , Midgley, J., Giarrusso, C., Laurent, C. , Jenson, I, Sumner, J.
545 (2007) An alternative process for cleaning knives used on meat slaughter
546 floors International. *Journal of Food Microbiology*, 113, 23–27
- 547 Gomes-Neves, E., Araújo, A. C., Ramos, E., & Cardoso, C. S. (2007). Food
548 handling: comparative analysis of general knowledge and practice in three
549 relevant groups in Portugal. *Food Control*, 18(6), 707–712.
- 550 Jacob, M. (1989). Safe food handling: A training guide for managers of food
551 service establishments. Geneva: World Health Organization.

- 552 Jevšnik M. , Hlebec, V. , Raspor, P. (2008) Food safety knowledge and
553 practices among food handlers in Slovenia, *Food Control* 19, 1107–111
- 554 Khandke, S. S., & Mayes, T.(1998). HACCP implementation: A practical guide to
555 the HACCP plan. *Food Control*, 9(2-3), 103–109.
- 556 Kirby, R. M., Bartram, J. & Carr, R. (2003). Water in food production and
557 processing: quantity and quality concerns. *Food Control*, 14(5), 283-299
- 558 Kowalski, K. M., & Vaught, C. (2002). Principles of adult learning: application for
559 mine trainers. *NIOSH Information Circular*, 946, 3–8
- 560 Kusumaningrum, H. D., Van Putten, M. M., Rombouts, F. M., & Beumer, R. R.
561 (2002). Effects of antibacterial dishwashing liquid on foodborne pathogens
562 and competitive microorganisms in kitchen sponges. *Journal of Food*
563 *Protection*, 65, 61–65.
- 564 Legnani P, Leoni E, Berveglieri M, Mirolo G, Alvaro N (2004). Hygienic control of
565 mass catering establishments, microbiological monitoring of food and
566 equipment. *Food Control*, 15, 205-211
- 567 Lues, J.F.R., Van Tonder, I (2007)The occurrence of indicator bacteria on hands
568 and aprons of food handlers in delicatessen sections of a retail group. *Food*
569 *Control*, 18, 326-332
- 570 MacAuslan, E. (2003). The boss, the owner, the proprietor...the food hygiene
571 manager? *The Journal of the Royal Society for the Promotion of Health*,
572 123(4), 229–232.
- 573 Martínez-Tomé, M., Vera, A. M. & Murcia, A. (2000). Improving the control of
574 food production in catering establishments with particular reference to the
575 safety of salads. *Food Control*, 11, 437-445.
- 576 Meyer, Bernhard (2006) Does microbial resistance to biocides create a hazard to
577 food hygiene? *International Journal of Food Microbiology*, 112 (2006) 275–
578 279

- 579 Mortimore, S., & Smith, R. A. (1998). Standardized HACCP training: assurance
580 for food authorities. *Food Control*, 9(2), 141–145.
- 581 Motarjemi, Y., Käferstein, F.(1999) Food safety, hazard analysis and critical
582 control point and increase in foodborne diseases: a paradox? *Food Control*,
583 10 (4–5), 325–333
- 584 Nel, S., Lues, J. F. R., Buys, E. M. & Venter, P. (2004). The personal and
585 general hygiene practices in the deboning room of a high throughput red
586 meat abattoir. *Food Control*, 15 (7), 571-578.
- 587 Newcombe, Robert G.(1998) "Two-Sided Confidence Intervals for the Single
588 Proportion: Comparison of Seven Methods," *Statistics in Medicine*, 17, 857-
589 872
- 590 Nieto-Montenegro SN, Brown JL, LaBorde LF (2008) Development and
591 assessment of pilot food safety educational materials and training strategies
592 for Hispanic workers in the mushroom industry using the Health Action
593 Model. *Food Control*,19, 616-633.
- 594 Notermans, S., Zwietering, M.H., Mead, G.C.(1994)The HACCP concept:
595 identifications of potentially hazardous micro organisms. *Food Microbiology*
596 11, 203–214
- 597 Pratten, J.D., Curtis, S., (2002). Attitudes towards training in UK licensed retail:
598 an exploratory case study, *Hospitality Management* 21, 393–403
- 599 Regulation (EC) No 852/2004 the European Parliament and of the Council of 29
600 of April 2004 , on the hygiene of foodstuffs. *Off. J. Eur. Comm.* 01.02.2002
601 L31, pp. 1–24.
- 602 Rennie, M. D. (1994). Evaluation of food hygiene education. *British Food*
603 *Journal*, 96(11), 20–25.
- 604 Rennie, M. D. (1995). Health education models and food hygiene education.
605 *Journal of the Royal Society of Health*, 115(2), 75–79.

- 606 Rhodes, L.B.(1988).In M.E. Rhodes (Ed.), Competency-based adult learning in
607 food safety programs in food protection technology II. Chelsea, MI: Lewis
608 Publishers
- 609 Roberts, D. (1990). Foodborne illness, sources of infection: food. *Lancet*, 336,
610 859-861.
- 611 Rusin, P., Maxwell, S., & Gerba, C. (2002). Comparative surface to-hand and
612 fingertip-to-mouth transfer efficiency of gram-positive bacteria, gram-negative
613 bacteria, phage. *Journal of Applied Bacteriology*, 93, 585-592.
- 614 Scott, E., & Bloomfield, S. F. (1990). The survival and transfer of microbial-
615 contamination via cloths, hands and utensils. *Journal of Applied Bacteriology*,
616 68, 271–278.
- 617 Seaman, P. & Eves, A. (2006). The management of food safety—the role of food
618 hygiene training in the UK service sector. *International Journal of Hospitality*
619 *Management*, 25, 278-296.
- 620 Seaman, P. (2010) Food Hygiene Training: Introducing the Food Hygiene
621 Training Model. *Food Control*, 21,381-387.
- 622 Shojaei, H, Shooshtaripoor, J., Amiri, M. .(2006) Efficacy of simple hand-
623 washing in reduction of microbial hand contamination of Iranian food
624 handlers. *Food Research International* 39 , 525–529
- 625 Smith, R. (1994). Food hygiene training: the chance to create a coherent training
626 policy. *British Food Journal*, 96(7), 41–45.
- 627 Sneed, J., Strohbehn, C., Gilmore, S. A., & Mendonca, A. (2004). Microbiological
628 evaluation of foodservice contact surfaces in Iowa assisted-living facilities.
629 *Journal of the American Dietetic Association*, 104(11),1722–1724.
- 630 Sun, Y. M. & Ockerman, H. (2005). A review of the needs and current
631 applications of HACCP system in foodservice areas. *Food Control*, 16(4)
632 325-332.

- 633 Toh, P. S., & Birchenough, A. (2000). Food safety knowledge and attitudes:
634 culture and environment impact on hawkers in Malaysia. Knowledge and
635 attitudes are key attributes of concern in hawkerfoodhandling practices and
636 outbreaks of food poisoning and their prevention. *Food Control*, 11, 447–452.
- 637 Van Zyl, A. P. (1998). *Red meat manual for veterinary public health*. Pretoria:
638 Directorate Veterinary Public Health.
- 639 Walker, E., Pritchard, C., & Forsythe, S. (2003). Food handlers' hygiene
640 knowledge in small food businesses. *Food Control*, 14(5), 339–343.
- 641 Williams, A. P., Smith, R. A., Gaze, R., Mortimore, S. E., Motarjemi, Y., &
642 Wallace, C. A. (2003). An international future for standards of HACCP
643 training. *Food Control*, 14, 111–121.
- 644 Wilson, E. B. (1927) Probable Inference, the Law of Succession, and Statistical
645 Inference, *Journal of the American Statistical Association*, 22, 209-212.
- 646 World Health Organization (2000). Foodborne disease: a focus for health
647 education. World Health Organization: Geneva.
- 648 World Health Organization (2003). Eighth report 1999-2000 of WHO Surveillance
649 Programme for control of foodborneinfections and intoxications in Europe.
650 Available from http://www.bfr.bund.de/internet/8threport/8threp_fr.htm.
- 651 Worsfold, D. (2001). Food safety behaviour in butchers' shops. *Nutrition & Food
652 Science*, 31(1), 13-18.
- 653

Table 1

Summary of the focus of the questionnaire contents

Questions “Knowledge”

HACCP- what is it?

Identify sterile food

What happens to bacteria at 37°C?

Food borne illness most frequent symptoms

Food borne illness agents transmission

Visual, olfactory or taste checks identify bacteria contaminated meat?

Meat Handler hygiene and health and food borne illness agents

Health conditions that are not acceptable in food handling

Potential health consequences of animal intestinal bacteria (*E. coli*, *salmonella*, *Campylobacter* and *Yersinia*)

Listeria monocitogenes and food borne illness

Dirty and Clean workspaces in the abattoir

Food borne agents inactivation

Temperature of knives sterilisers

Questions “Practice”

Working surfaces and instruments washing requirements and products

Potable water use/Water supply

Red Meat storage temperatures

Chopped meat storage temperatures

Freezing temperatures for meat

Temperature ranges and food poisoning agents development

Different situations that imply hand washing before food handling

Different steps to correct hand wash

Cross contamination and change of working instruments and clothes

ACCEPTED MANUSCRIPT

Table 2

Demographic data and job information of the participants

Participants (N=159)	Average \pmSD	Minimum-Maximum
Age (N=155)	35.19 \pm 10.15	16-58
Years of formal education (N=151)	6.50 \pm 2.59	0-13
Age at the beginning of the professional activity (N=153)	15.68 \pm 2.53	9-24
Years of experience in the same activity (N=133)	12.65 \pm 9.35	0 - 35
Years in the present company (N=154)	8.89 \pm 7.57	0 - 33

Table 3

Percentage of correct answers to the “Knowledge” and “Practice” questions within each group defined by professional training.

<i>Participant Group</i>	<i>Question Group</i>	
	Knowledge	Practice
	N=14 questions	N=10 questions
GPI (N=36)	66.92±16.36 ¹	70.53±17.47
WSH (N=19)	49.21±22.77	58.33±19.93
BT (N=60)	67.26±21.05	68.67±22.58
NT (N=39)	47.89±22.63	63.44±21.70
one-way ANOVA	d.f. =3 F= 10.393 p=0.000	d.f.=3 F=3.986 p=0.009

¹Mean±1SD

Table 4A

Percentage of correct answers and 95% Confidence Intervals*(CI) of the questions “Knowledge” (qualitative results)

<i>Questions</i> “Knowledge”	% of Correct Answers (95% CI)			
	GPI	WSH	BT	NT

	N=361	N=19	N=60	N=39
What is HACCP?	63.2 (38.6-82.8)	22.2 (10.7-39.6)	51.7 (38.5-64.6)	17.9 (8.1-34.1)
Identify sterile food	21.1 (7.0-46.1)	25.0 (12.7-42.5)	31.7 (20.6-45.1)	28.2 (15.6-45.1)
What happens to bacteria at 37°C?	89.5 (65.5-98.2)	61.1 (43.5-76.4)	83.3 (71.0-91.3)	59.0 (42.2-74.0)
Food borne illness most frequent symptoms	100.0 (79.1-100.0)	77.8 (60.4-89.3)	95.0 (85.2-98.7)	71.8 (54.9-84.4)
Food borne illness agents transmission	73.7 (48.6-89.9)	52.8 (35.7-69.2)	65.0 (51.5-76.5)	56.4 (39.8-71.8)
Visual, olfactory or taste checks identify bacteria contaminated food?	42.1 (21.1-66.0)	41.7 (26.0-59.1)	45.0 (32.3-58.3)	51.3 (35.0-67.3)
How can MH contaminate meat?	73.7 (48.6-89.9)	55.6 (38.3-71.7)	85.0 (72.9-92.5)	56.4 (39.8-71.8)
MH can get ill in consequence of meat handling?	47.4 (25.2-70.5)	63.9 (46.2-78.7)	88.3 (76.8-94.8)	51.3 (35.0-67.3)
Health conditions that are not acceptable in food handling	47.4 (25.2-70.5)	36.1 (21.3-53.8)	65.0 (51.5-76.5)	30.8 (17.5-47.7)

Potential health consequences of animal intestinal bacteria	100.0 (79.1-100.0)	58.3 (40.9-74.0)	75.0 (61.9-84.9)	43.6 (28.2-60.2)
<i>Listeria monocitogenes</i> and food borne illness	68.4 (43.5-86.4)	36.1 (21.3-53.8)	53.3 (40.1-66.1)	33.3 (19.6-50.3)
Dirty and Clean workspaces in the abattoir	78.9 (53.9-93.0)	52.8 (35.7-69.2)	80.0 (67.3-88.8)	48.7 (32.7-65.0)
Food borne agents inactivation	52.6 (29.5-74.8)	50.0 (33.2-66.8)	56.7 (43.3-69.2)	48.7 (32.7-65.0)
Temperature of knives sterilisers	78.9 (53.9-93.0)	55.6 (38.3-71.7)	66.7 (53.2-78.0)	59.0 (42.2-74.0)

* Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe, 1998)

Table 4B

Percentage of correct answers and 95% Confidence Intervals* (CI) of the questions "Practice" (qualitative results)

Questions "Practice"	% Correct	Answers	(95% CI)	
	GPF	WSH	BT	NT
	N=36	N=19	N=60	N=39
Working surfaces and instruments washing	84.2 (59.5-95.8)	94.4 (80.0-99.0)	90.0 (78.8-95.9)	89.7 (74.8-96.7)
Working surfaces and instruments disinfection products	47.4 (25.2-70.5)	36.1 (21.3-53.8)	58.3 (44.9-70.7)	43.6 (28.2-60.2)
Potable water use for washing purposes	57.9 (34.0-78.9)	58.3 (40.9-74.0)	61.7 (48.2-73.6)	59.0 (42.2-74.0)
Temperature ranges and meat preservation	36.8 (17.2-61.4)	27.8 (14.8-45.4)	38.3 (26.3-51.8)	25.6 (13.6-42.4)
Red Meat storage temperatures	100.0 (79.1-100.0)	63.9 (46.2-78.7)	83.3 (71.0-91.3)	74.4 (57.6-86.4)
Chopped meat storage temperatures	68.4 (43.5-86.4)	38.9 (23.6-56.5)	56.7 (43.3-69.2)	43.6 (28.2-60.2)
Freezing temperatures for meat	57,9 (34.0-78.9)	47,2 (30.8-64.3)	56,7 (43.3-69.2)	41,0 (26.0-57.8)
Different situations that imply hand washing before meat handling	100.0 (79.1-100.0)	100.0 (88.0-100.0)	86.7 (74.9-93.7)	84.6 (68.8-93.6)
Different steps to correct hand wash	78.9 (53.9-93.0)	52.8 (35.7-69.2)	70.0 (56.6-80.8)	43.6 (28.2-60.2)
Cross contamination and change of working instruments and clothes	21.0 (7.0-46.1)	27.8 (14.8-45.4)	31.7 (20.6-45.1)	33.3 (19.6-50.3)

* Wilson procedure with a correction for continuity (Wilson, 1927; Newcombe, 1998)