

EUROPEAN CONSUMER ATTITUDES TOWARDS THE CONSUMPTION OF 3D-PRINTED STEAK

Petra Chaloupkova¹, Tersia Needham^{1*}, Claire Durand², Stephen Onakuse³, Ladislav Kokoska¹

¹Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague

²ISTOM, École Supérieure d'Agro-Développement International, Angers, France

³Cork University Business School, University College Cork, Ireland

*Corresponding author email: needham@ftz.czu.cz

I. INTRODUCTION

Cell-cultured meat has received much attention of late, being presented as an alternative to conventional meat, citing benefits such as decreased need for large-scale animal production, positive effects on the environment, indirect benefits for animal welfare, control of zoonotic health risks etc. [1,2]. Recently has 3D-printing has enabled the transformation of bovine muscle, fat, and vessel cells into steak-like tissue [3]. This technology thus presents potential for mimicking conventional muscle cuts, and not just processed products like burgers or sausages. 3D-printing could produce steak that may well mimic the sensory eating quality of conventional steak, or allow consumers to customise it to their liking, whilst addressing some of the negative aspects of conventional meat production, potentially opening the meat market to consumers who chose to decrease or omit meat consumption due to issues linked with animal ethics, health-risk, environmental impact, and sensory qualities. However, studies focusing on perceptions and attitudes towards 3D printed foods in general have shown that consumer attitudes towards 3D-printed meat and meat products is rather negative [1], with consumer distrust in the technology cited as important contributors. The aim of this study was to investigate consumer attitudes to 3D-printed meat exclusively, after being provided information about meat 3D-printing technology and its potential benefits.

II. MATERIALS AND METHODS

Quantitative data was collected through a consumer survey among 571 respondents in three selected European countries (France, Czech Republic, and Ireland). Participation was voluntary and self-administered to all participants who answered the questionnaire anonymously. Sociodemographic data was collected. The cross-sectional questionnaire consisted of 11 multiple-choice questions focused on awareness and willingness to consume 3D printed meat. All participants were asked to evaluate their meat consumption habits, which were subsequently divided into three categories: meat consumers (meat eaters and flexitarians), partly meat consumers (pollotarians and pescatarians) and no meat consumers (vegetarians and vegans). Responses were reported using a 5-point Likert scale, ranging from "Strongly agree", through "neither disagree nor agree" to "Strongly disagree". Data was analysed in Statistica, utilizing Kruskal-Wallis ANOVA and multiple comparisons of mean ranks.

III. RESULTS AND DISCUSSION

Of all respondents, 62% were women, primarily 18-30 years of age (67% of all respondents), with a university education (81%), and living in urban areas (70%). Meat consumers were the most numerous respondents (74%), then no meat consumers (17%), and finally partly meat consumers (9%). While all consumer groups confirmed that they would be interested in trying 3D printed meat (Table 1), meat consumers were more willing, followed by partly meat consumers, and then no meat consumers, even though no meat consumers had greater awareness about 3D printed meat technology. When asked

which factors would influence their willingness to consume 3D-printed meat, meat and partly meat consumers ranked economic value and taste higher than no meat consumers; on the other hand, animal ethics was ranked higher amongst partly and no meat consumers than meat consumers. Environmental impact was ranked higher for partly meat consumers than the other consumer groups. In terms of willingness to purchase, price and freshness were important parameters for meat and partly meat consumers. Environmental impact, health impact, animal ethics, and social influence were factors that would likely influence consumer willingness to try 3D-printed meat; however, consumer's knowledge regarding 3D-printed meat technology was low, which may have also influenced their willingness to try 3D printed meat products. Despite this, price was still the most important factors determining willingness to purchase 3D-printed meat.

Table 1 Mean rankings, based on a 5-point Likert scale, regarding consumer awareness about 3D-printed meat, factors influencing their willingness to try 3D-printed meat, and factors that would determine their willingness to purchase 3D-printed meat.

	All	Meat consumers	Partly meat consumers	No meat consumers	SEM	P
Awareness about 3D-printed meat						
I have heard about 3D printed meat	2.69	2.56 ^b	3.02 ^a	3.13 ^a	0.066	0.014
I know how 3D printed meat works	1.82	1.80	1.71	1.95	0.046	0.362
I would try 3D printed meat	3.41	3.46 ^a	3.23 ^b	3.25 ^c	0.060	<0.001
Factors influencing willingness to consume						
Economic value	3.31	3.38 ^a	3.42 ^a	2.93 ^b	0.056	0.014
Taste	3.58	3.65 ^a	3.75 ^a	3.18 ^b	0.058	0.018
Nutritional value	3.43	3.44	3.69	3.25	0.055	0.178
Impact on health	3.62	3.63	3.83	3.44	0.055	0.290
Environmental impact	3.82	3.73 ^b	4.35 ^a	3.93 ^b	0.055	<0.001
Animal ethics	3.58	3.44 ^b	4.10 ^a	3.95 ^a	0.057	<0.001
Social influence	2.75	2.77	2.98	2.57	0.043	0.149
Religious reasons	1.57	1.58	1.85	1.39	0.058	0.148
Factors determining willingness to purchase						
Price	3.66	3.66 ^a	4.06 ^a	3.12 ^b	0.056	0.004
Origin/traceability	3.46	3.46	3.69	3.31	0.056	0.422
Freshness	3.58	3.58 ^{ab}	3.88 ^a	2.95 ^b	0.056	<0.001

^{a,b}Values with different superscripts differ at $P < 0.05$ between consumer groups; SEM: pooled standard error of the mean

IV. CONCLUSION

Different consumer groups indicated separate factors that would play important roles in their decisions to consume and purchase 3D-printed meat, especially regarding the no meat consumers. Should 3D-printed meat enter the formal market in the near future, marketing should likely focus on dissemination of information regarding meat 3D-printing technology and consider its possible impacts on the environment, health, and animal welfare.

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