

'In Vitro' Meat – A Preliminary Examination of Irish Consumer Acceptance

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Abstract— Increasing global food demand, driven by population growth and rising incomes have important implications for food security and sustainability. The consequences of current agricultural practises and conventional livestock production are as a result being examined and alternatives sought. As such the development of an alternative meat production system may be found in the tissue engineering of skeletal muscle. The basic methodology of an *in vitro* meat production system (IMPS) involves culturing muscle tissue in a liquid medium on a large scale [1]. The objective of this research is to examine potential acceptance of such a system by Irish consumers. A qualitative approach was taken given consumers' low level of knowledge regarding the technology. Guided by the literature, a novel methodology was applied involving observations of a one-to-one deliberative discourse (conversation) between a food scientist and consumers. Consumers were presented with pre-defined hypothetical scenarios (designed in conjunction with the scientist), illustrating the benefits and risks of hypothetical *in vitro* meat applications across animal types. Consumers also participated in pre and post-discourse interviews to determine the influence of the discourse on acceptance (n = 5; 15 observations in total). Consumers initially reacted negatively towards the concept of the technology, perceiving it to be unnatural. However, they reacted more favourably if the technology resulted in improved animal welfare and the improved nutritional value of meat products and, to a lesser extent, reduced environmental impacts. The type of meat also influenced acceptance, indicating a 'hierarchy' of acceptance. A number of factors influencing acceptance have been identified in this exploratory research, providing focus for future work.

Keywords— *in vitro* meat, consumer acceptance, deliberative discourse.

I. INTRODUCTION

By 2050 the world's population is projected to reach 9.1 billion, with significant growth projected to

take place in developing countries. Alongside this, urbanisation and income levels will continue to rise. As a result food production must increase by 70 percent and annual meat production will need to reach 470 million tonnes (up over 200 million tonnes on current levels) [2]. Given these forecasts global food supply must increase sustainably within the context of increasing competition for natural resources, particularly land and water, competition between food, feed and biofuel, and by the need to operate in a carbon-constrained economy [3]. Within the broader sustainability debate the environmental impact of agriculture is currently the focus of much attention. Agriculture is a major contributor to greenhouse gas (GHG) emissions, principally from methane and nitrous oxide. Together with animal feed production, meat production methods are estimated to contribute between 15% and 24% of global GHG emissions [4]. There is therefore a growing imperative to address this issue. As such, alternative, more efficient and productive methods of meat production are thus being explored. An *in vitro* meat production system (IMPS) has been put forward by some as one such alternative.

Fundamentally, an IMPS involves culturing muscle tissue in a liquid medium on a large scale [1]. The basic approach employs the growth of myoblasts or myosatellite cells on a scaffold in a culture medium within a bioreactor [1]. The growth medium, necessary for the proliferated cells to grow, contains nutrients, basic amino acids and glucose. This can be supplemented with foetal bovine serum [5] or plant based alternatives. Force is then applied causing the cells to fuse and form muscle fibres.

The utilisation of *in vitro* meat in ground, processed goods such as hamburgers and sausages seems more technically feasible than its presentation in a form resembling traditional meat cuts in the short term. In the ground form, the textural shortcomings of the *in vitro* grown product are not likely to compromise the

final processed product. As a result, according to Datar and Betti (2010) this type of product may be more acceptable to consumers.

Aside from the potential environmental benefits of such a system many other efficiency arguments have been made [7]. Meat produced *in vitro* would result in less waste as unwanted skeletal tissue and offal would not be produced and ethical concerns with regard to animal welfare, disease and intensive rearing practises could also be addressed. As the product would be cultured in sterile, controllable conditions, it would also be more hygienic, potentially minimising the risk of foodborne illness [5]. Such a system could also provide a healthier alternative to conventionally reared red meat as the nutritional composition of *in vitro* meat could be altered and/or nutrients added by selecting cells from particular animals or through genetic modification. However, aside from technical challenges around creating an *in vitro* 3D muscle with acceptable texture, the principle obstacles to the commercial implementation of an IMPS are consumer acceptance (particularly perceived unnaturalness of the concept and the inherent ‘yuck factor’) [8] and cost effectiveness on a large scale [1]. While consumer acceptance may be challenging, the potential negative connotations may be off-set by potential positive impacts. The purpose of this paper is to examine likely acceptance of *in vitro* meat by Irish consumers.

II. MATERIALS AND METHODS

A qualitative research approach was taken given the low levels of public knowledge about *in vitro* meat technology. A novel methodology was applied involving observations of a one-to-one deliberative discourse (conversation) between a food scientist (specialising in the area of meat quality) and consumers, during which they discussed *in vitro* meat production. The primary objective of this approach was to understand the evolving perspectives of the individual consumer about this technology as information was presented to them. The discourse was a two-way communication process whereby the consumer had the opportunity to question the scientist at any stage. Discourses were undertaken with consumers from different socio-demographic

backgrounds in an attempt to capture the diversity of perceptions likely to be present in the population.

Furthermore, in depth pre and post-discourse interviews were undertaken with participants to determine the perceived influence of the discourse on acceptance and the factors contributing to any attitudinal change. Therefore, each consumer (n = 5) participated in three interactions (15 observations in total). The pre-discourse interview with consumers established their baseline knowledge and attitudes towards the production of *in vitro* meat. None of the participants were aware of the concept and were provided with a brief summary sheet which included a factual (neutral) description of the technology absent of perceived benefits and risks so as not to influence their attitudes. This ensured that all participants had a minimum level of information and a basic awareness of *in vitro* meat prior to interacting with the scientist.

The discourse commenced with the scientist providing an overview of the technology. A number of pre-defined hypothetical scenarios were then presented. These were developed following a literature review and in consultation with the scientist. Consumers were probed throughout the process to ascertain how they framed their views as additional information was presented, in an effort to gauge ‘tipping points’ in acceptance. The scenarios illustrated a number of potential benefits and risks; from a consumer, societal, environmental and industry perspective. They were futuristic in nature and were set in the context of a rising world population and increasing demand for food. The aim was to elicit consumer acceptance of an *in vitro* meat product presented as a viable alternative to a potentially scarce, conventionally produced product in the year 2050. The first hypothetical application illustrated how *in vitro* meat could be used as an alternative to conventionally produced mince meat (this could be cooked by consumers or used as an ingredient for processors). The second outlined how more structured cuts of meat could in theory be produced; e.g. *in vitro* produced substitutes for traditional beef steak and chicken and fish fillets. Finally, a brief questionnaire was completed by participating consumers, during the post discourse interview, to support some of the qualitative findings. Thematic analysis of the qualitative data was then undertaken.

III. RESULTS

The pre-discourse interviews with participating consumers revealed they were unaware of the concept of *in vitro* meat production. An adverse initial reaction was then somewhat uniformly held, arising from their perceptions of the process being unnatural: “*it sounds revolting...real Star Trekky...it’s too way out*” (C4); “*...it’s like when they...grow an ear on the side of a mouse or something.*” (C2). However, information received during the discourse appears to have positively influenced their attitudes and the majority displayed an increased likelihood of purchasing such products after participating in the discourses. It should be acknowledged that whilst efforts were made to ensure that only unbiased factual information was presented, the nature of the research and the provision of information may have positively framed participants’ attitudes.

Participants were positive towards the concept of the use of this technology resulting in improved animal welfare and improved nutritional value of meat products and, to a lesser extent, reduced environmental impacts. In particular, the ability to tailor-make *in vitro* meat products for specific medical or dietary needs was positively perceived by all of the participants. There was some apprehension within the group about the use of genetic modification (GM) to this end; selective breeding to obtain ‘starter’ cells of superior nutritional status was preferred. General acceptance was conditional on safety assurances being guaranteed (by food safety authorities and other consumers): “*Regulation and honesty in all food is important*” (C5). Trust in the regulatory authorities also framed attitudes positively: “*They wouldn’t give it to me if it was harmful.*” (C4).

Specific product characteristics also framed participants’ acceptance. The concept of the taste and texture of *in vitro* meat products being sub-optimal was a potential ‘tipping point’ in acceptance. This was particularly evident when discussing *in vitro* steak: “*I would try it, but if I didn’t like it I just wouldn’t buy it again*” (C5). Participants were hesitant when informed that the texture of a non-minced product (e.g. steak) could be slightly inferior: “*I think there seems to be no substitute for that muscle fibre from something...running around...*” (C2). A vegetarian in the group (who had previously eaten meat) would,

however, be willing to at least try such a product: “*You know the one thing you would miss as a vegetarian might be the texture of meat*” (C3). Participants generally felt that any sensory shortcomings arising with a minced product could be more easily overcome by using sauces in cooking etc.

Trade-offs between benefits and costs also formed part of the framing for acceptance or rejection. For example, participants were generally unwilling to pay a price premium for an *in vitro* meat product if it would be of inferior quality. On welfare grounds, however, most would be willing to pay extra for an *in vitro* alternative to intensively reared chicken or farmed fish. Participants appeared to display a ‘hierarchy of approval’, with regard to their acceptance of different types of *in vitro* meat and tended to be more favourable towards *in vitro* chicken than beef, on welfare grounds. Hallman (2000) highlighted the existence of such a hierarchy in terms of consumer acceptance of GM foods; consumers have, generally, been found to be more accepting of plant versus animal GM applications [9].

Animal welfare and ethical issues (i.e. IMPS as a potential solution to the ethical dilemma inherent in slaughtering animals for the consumption of meat) positively framed attitudes for some. One participant considered it to be: “*an interesting get out of jail card... if it’s slaughtering one animal to produce enough food to feed one hundred people that’s fair enough*” (C3).

Individual perspectives and values also framed participants’ overall attitudes. In particular, most participants questioned the potential impact of this technology on farming practises within Ireland and the landscape: “*I would have a negative perception of that [change] definitely*” (C1). However, one participant perceived such change positively, believing it represented an improvement over conventional practices: “*[current] farming [practices]... it’s a manufacturing process for animals....it just doesn’t sit well with me...*” (C3).

Participants’ reactions were not particularly emotive when informed that an IMPS would be controllable, resulting in less risk of foodborne illness. In fact, some were cynical: “*...if you have a laboratory environment...if something gets in there it’s like...bleurgh...it will run amok...*” (C2).

Interference with the food chain was perceived negatively by some who linked this directly to the occurrence of bovine spongiform encephalopathy (BSE).

One interesting aspect was the issue of personal versus societal relevance; consumers were supportive of the technology due to the elimination of animal suffering, but particular product characteristics and personal needs appeared to be somewhat more important than the societal issues of the environment and global food supply. A reduction in GHG emissions positively framed attitudes for some; however, its impact was not significant. In fact one consumer took quite an alternative view: *“I think...you can cut down on cars...a lot can be done on renewables and stuff. But I still think we should... still keep our animals.”* (C1).

The main barriers to consumer acceptance arising from this research were issues with regard to texture, quality and the perceived unnaturalness of the process (i.e. the ‘yuck factor’). Product characteristics (i.e. type of meat, nutritional improvements) and environmental issues (i.e. improvements to animal welfare and sustainability, particularly relating to the depletion of fish stocks) positively framed participants’ attitudes.

IV. CONCLUSIONS

IMPS is currently in the developmental stage and much research is still needed to establish it on a sustainable industrial scale [7]. However, it is gaining increasing media attention [10] and it is therefore important to gain insights into consumer acceptance of this evolving and potentially controversial technology at an early stage [11] given the scale of investment required to commercialise this technology. Several factors influencing consumer acceptance have been identified in this exploratory research, which provide focus for future work. While the number of participants in this study was small and the findings are not claimed to be representative of all Irish consumers, nonetheless this research highlights the factors framing consumers’ attitudes and acceptance and indicates the relevance of the issues raised at a broader level.

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