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# Designing market-oriented beta-glucan enriched functional foods through conjoint analysis: evidence of differing consumer preferences

Joe Bogue and Amy-jane Troy [a]

Department of Food Business and Development, University College Cork, Ireland.[a]

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# Designing market-oriented beta-glucan enriched functional foods through conjoint analysis: evidence of differing consumer preferences

Joe Bogue [a,1] and Amy-jane Troy [a]

Department of Food Business and Development, University College Cork, Ireland.[a]

**Abstract.** *New product development (NPD) has a significant role to play in the rapidly evolving food supply chain where firms wish to utilise innovative novel ingredients to meet consumers' increased needs for healthier foods. It is a knowledge intensive process where the generation of new ideas and concepts requires detailed knowledge of both products and consumers. Beta-glucan, a novel soluble fibre, is of major interest to global food firms for its ability to increase the functionality of food and beverage products through increasing the soluble fibre content. The determination of intrinsic and extrinsic product attributes that maximise consumer acceptance of beta-glucan enriched products is largely dependant on a market-oriented NPD process. This study utilised a Conjoint Analysis methodology to examine the tradeoffs consumers would make during the purchasing decision process for healthy beta-glucan enriched breads. Three hundred consumers rated twenty-two hypothetical products on a nine-point Likert scale according to their willingness to purchase. This research identified key attributes which determined consumers' preferences for these enriched products and identified four viable consumer segments. Managing customer knowledge during the early stages of the NPD process can help firms overcome customer acceptance issues associated with innovative functional ingredients and encourage firms to respond to new market opportunities along the food supply chain.*

**Key words**: Knowledge Management, Market orientation, Conjoint Analysis, Beta-glucan.

# 1. Introduction

## 1.1 New product development and the evolving supply chain

NPD is a knowledge intensive multi-stage process where the generation of new ideas and concepts requires a detailed knowledge of both the product and the consumer with input from commercial, academic and regulatory interests [1, 2, 3]. Successful NPD within the supply chain has become a strategic necessity for global food and beverage firms who wish to compete in the rapidly evolving health and wellness market [4]. Product innovations and product differentiation are keys in the challenge to provide consumers with a healthier diet [5]. Approaches to NPD that integrate consumer information into the NPD process have emerged as one of the major areas for international firms to gain a competitive edge in the supply chain and increase overall acceptance of novel products, such as functional foods [6]. An in-depth knowledge of what consumers want, how their needs change and how such changes can be promptly addressed within the supply chain has become not only a success factor for agri-food businesses, but one that enhances the chances of business survival [7].

Supply chain integration has often been described as the seamless flow of products and information from supplier to customer [8]. Wang *et al.* believed the most important goal of supply chain management was to meet customers' demands more efficiently and in the case of international food and beverage companies, to make the right product, for the right customer, in the right amount and at the right time [9]. The use of effective knowledge management within the supply chain has a significant impact on a firm's ability to target and meet consumers' needs more effectively [10]. Knowledge management has been regarded as a critical tool for the promotion of creativity in the NPD process and critical to the idea generation stage [11, 12, 13]. A growing body of evidence supports the notion that consumer involvement in the NPD process, combined with an effective knowledge management system in both the idea generation and development stages of the NPD process, can aid in the development of a more thorough and meaningful product concept. This can reduce the number of late changes to products and thus lowers the cost to the producer, both in terms of time and financial resources utilised by developers [14, 15, 16,17, 18].

[1] Corresponding author: Tel.: +353 21 4902355; Fax.: +353 21 4903358; Email: j.bogue@ucc.ie

## 1.2 Functional foods and beta-glucan

The overall market for health and wellness products is growing throughout the advanced industrial world and the EU market, which is one of the world's largest markets for functional ingredients and nutraceuticals, was worth €65 billion in 2007 [19]. Varying definitions for functional foods have made the determination of the market value difficult. The International Food Information Council (IFIC) describe a functional food as: any food or food component that provides a health benefit over and above basic nutrition [20]. Functional food and beverages are purchased by consumers for a number of reasons which predominantly relate to the additional health benefit(s) they provide through consumption. A functional food or beverage can be seen as the sum of a set of intrinsic and extrinsic cues [21]. Intrinsic cues are product attributes inherent to the objective nature of the product itself; and conversely, extrinsic cues are any product characteristics that can be altered without influencing the objective nature of the product or service [22]. The fulfilment of consumers' needs in a profitable way requires that food manufacturers understand which aspects of a product, both intrinsic and extrinsic, are of most value to the consumer [23]. In the case of functional foods, consumer perceptions about the healthiness of the food types, associated health claims and enrichment components have a significant impact on consumer acceptance of such products [24]. The rapid growth of food related non-communicable diseases and the consequent increased desire for a healthier diet has created significant opportunities for functional food product developers [25]. The extent and cost of diet-related health problems has focused governments' attention on dietary solutions and has also encouraged the increased marketing and consumption of cereals perceived as healthy, such as oats [26, 27, 28, 29].

Beta-glucan, a natural soluble fibre has been used to increase the functionality of food and beverage products developed for the health and wellness market [30]. Beta-glucan is abundant in cereals such as oats and barley and present in varying amounts in seaweed, fruits and vegetables [31]. Beta-glucan has received significant medical interest for its health promoting properties, particularly those related to: LDL cholesterol reduction, reduced risk of coronary heart disease and potential reduction in the development of Type-2-diabetes [32, 33, 34, 35]. The long-term success of novel foods may be achieved through the strategic marketing of their functional benefits, such as marketing beta-glucan enriched products with an emphasis on the reduction of current health problems, such as cardiovascular disease, cholesterol levels and diabetes [36].

# 2. Research Methodology

## 2.1 Research objectives

The objectives of this research were: to incorporate the 'voice of the consumer' in the idea generation and product design stages of the NPD process to allow for efficient and effective knowledge management; to determine which intrinsic and extrinsic product attributes would influence consumer acceptance of novel beta-glucan enriched products; and to segment the market based on consumers' acceptance of these new products.

## 2.2 Research methodology

A research methodology refers to the procedural framework within which the research is conducted [37]. Although Cooper and Kleinschmidt emphasised that the use of certain tools, methods or models such as brainstorming, focus groups, conjoint analysis and concept testing did not guarantee NPD success, they found their use and implementation an important element in the management of knowledge integration throughout the NPD process [38, 39, 40, 41]. Their utilisation can be used to improve management's decisions at different stages of the NPD process and thus to improve the overall success rate of new products [42, 43, 44]. Such improvements are significant as new product failure rates remain high, and the costs of failure are substantial [45, 46]. In this research data retrieved from qualitative research carried out in the form of focus groups and semi-structured interviews was used to inform the design of the Conjoint Analysis questionnaire. Information gathered from both consumers and technical partners within the research team informed the design of a set of attributes and corresponding value levels to investigate consumers' reactions to beta-glucan enriched breads.

Conjoint Analysis is a multivariate technique and can be used for measuring customer preferences, through utility tradeoffs, among products developed to specifically understand how respondents have preferences for any type of object, that is, products, services or ideas [47, 48]. This decompositional technique can be used to derive part worth estimates associated with selected aspects or attributes of a choice alternative on the basis of the overall preference statements of a group of respondents [49, 50]. It is based on the simple premise that consumers evaluate the value of an object, real or hypothetical, by combining the separate amounts of value provided by each attribute [51, 52]. This enables the development of a product which creates the most value for consumers. Through the use of the orthogonal design application in SPSS v15 an orthogonal main-effects design was generated which permitted the statistical testing of six attributes and eighteen attribute levels, without testing every combination of factor levels [53] (Table 1). A possible combination of such attribute levels is frequently referred to as a 'profile' [54]. This resulted in the generation of twenty-two hypothetical beta-glucan enriched breads. The generation of a limited number or suitable reduced subsample of the complete or full set of all product profiles ensured that the survey was as consumer friendly as possible [55].

**Table 1 Attributes and Attribute Levels Utilised in the Conjoint-based Survey**

| **Product Attribute** | **Attribute Level** |
|---|---|
| Brand | Mainstream<br>Specialty<br>Co-brand |
| Description | Gluten-free<br>Health loaf<br>Low-allergen |
| Beta-glucan Source | Oats<br>Barley<br>Seaweed |
| Health/Nutritional Claim | Reduced risk of cardiovascular disease<br>Reduced cholesterol levels<br>Stabilisation of blood sugar levels |
| Price | €1.90 per 400g<br>€2.60 per 550g<br>€3.70 per 800g |
| Bread-type | White high fibre<br>Wholesome wholegrain<br>Wholemeal brown |

After a pilot test determined the validity of the conjoint model, twenty-two product profiles were presented to 300 consumers, in the form of a paper-based questionnaire for rating on a nine-point Likert Scale. The questionnaire was designed to generate demographic and behaviour-attitude information. The distribution of questionnaires occurred between June and July 2008 in Dublin City and Cork City, Ireland. In order to gain a representative sample of the population, participants were recruited through stratified random sampling [56]. The questionnaires were administered to houses using the drop off and collect method of questionnaire administration [57]. A total of 297 questionnaires were returned fully completed. A discrete conjoint model was used for this study, which meant no assumptions were made regarding a relationship between attributes and product scores [58]. The full-profile conjoint methodology was employed through the use of SPSS v15 as it was most suited to the low number of attributes which were under consideration [59]. A fractional factorial design generated an orthogonal array which captured the main effects for each factor level. This resulted in twenty-two hypothetical beta-glucan enriched bread profiles being developed which included four holdout profiles. These four holdout profiles were rated by consumers but were not included in the building of the preference model but used at a later stage to check the validity of the model [60].

## 2.3 Data analysis

The individual level conjoint analysis procedure in SPSS v15 calculated the range of utility values for each attribute and attribute level. A utility is an individual's subjective preference judgement representing the holistic value or worth of a specific object [61]. In Conjoint Analysis, utility is assumed to be formed by the combination of part-worth estimates for any specified set of levels [62]. Part-worths provide a quantitative measure of the preference for each factor level and larger part-worth values corresponded to greater preferences [63]. The validity of the model in this research was then assessed by the association measures, Pearson's R and Kendall's tau. Values close to one indicated strong agreement between the average product ratings and the predicted utilities from the conjoint model [64].

K-Means Cluster Analysis segmented consumers into groups based on attribute utility patterns. The aim of this clustering method was to minimise variability within clusters and maximise variability between clusters [65]. This type of segmentation, based on utility values rather than only demographic variables was more specifically geared to the evaluation of products and concepts [66]. K-means Cluster analysis works by defining the number of clusters *a-priori.* For this reason, a Hierarchial Cluster Analysis was first carried out to help reveal the number of relevant clusters from an agglomeration schedule. The agglomeration schedule illustrates large changes in the coefficient numbers which reflects a significant change from one cluster to another [67].

The information derived from the relative importance of attributes and utility levels then allowed for the completion of a simulation analysis. Simulations are used to convert part-worth utilities into simulated market choices. The simulation allows for the identification of idiosyncratic preferences which occur at an individual or group level [68]. Kendall's tau correlation coefficient for the four holdout cards was used to determine how consistently the conjoint model could predict consumers' preferences for a new beta-glucan enriched bread. A value close to one was necessary to carry out the analysis of beta-glucan enriched bread concepts which were not presented to consumers in the conjoint questionnaire [69]. In this study, both maximum (Maximum Utility) and probability models (Bradley Terry Luce – BTL and Logit) were utilised.

# 3. Results

## 3.1 Averaged importance scores

There were almost equal numbers of male and female respondents, 51% and 49% respectively, with 60% of the population between the ages of 18 and 39. A total of 44% of the sample had completed third-level education while 23% were pursuing further education. The averaged importance scores (Table 2) indicated which attribute carried more weight in the overall decision-making process. It was found that bread type (25.229/100) and price/portion size (17.310/100) were the most influential attributes which would affect the purchase of a beta-glucan enriched bread. The values for Pearson's R (0.997) and Kendall's tau (0.935) were close to one, which indicated strong agreement between the average product ratings and the predicted utilities from the conjoint model. The Kendall's tau associated with the four holdout cards of 1.0 further augmented the validity of the model. The first stage of the Conjoint Analysis calculated consumers' overall preferences for product attributes.

**Table 2 Average Importance Score for Product Attributes**

| Attribute | Avg. Importance Scores |
|---|---|
| Brand | 15.011 |
| Description | 12.822 |
| Beta-glucan Source | 15.196 |
| Health/Nutritional Claim | 14.432 |
| Price | 17.310 |
| Bread-type | 25.229 |

An inverse linear relationship between price and utility value existed with an increased utility value associated with the lowest price. Two hundred and fifteen consumers displayed a price reversal.

However, these reversals cannot be used to provide a realistic reflection of consumers' attitudes towards the price of a beta-glucan enriched bread as price was directly related to portion size in this study. The sample indicated preference for a brown, co-branded beta-glucan enriched bread, marketed on the health benefits of reduced cholesterol levels.

## 3.2 K-means Cluster Analysis

Four consumer segments with similar preferences for beta-glucan enriched breads were identified through the use of K-means Cluster Analysis. The socio-demographic profiles of each cluster are illustrated in Table 3. All four groups displayed a positive utility for bread which was co-branded and sold at a price of €2.60, equivalent to a 550g loaf (See Table 3).

Cluster 1, the largest segment, consisted of similar numbers of single and married males and females with an average income, most concentrated between the ages of 18 and 34. Price was the most important product attribute for these price-sensitive consumers (utility = 0.45). Consumers in this group indicated a preference for bread described as white high fibre (utility = 0.39) and marketed under a mainstream brand (utility = 0.16).

Cluster 2 contained 71 consumers who were mainly married females between the ages of 18 and 44. Bread-type was the most significant product attribute for these consumers. A distinct preference for bread described as wholesome wholegrain (utility = 1.28) and wholemeal brown (utility = 1.18) was evident. This group displayed an increased preference for a co-branded bread (utility = 0.21). Consumers in this group were most likely to believe that beta-glucan was beneficial to their health and were most willing to consume a beta-glucan enriched bread. Similar to the other three clusters, consumers in this group had a negative utility (-0.01) for beta-glucan from a seaweed source. This was the only cluster that had a lower utility value (-0.11) for barley beta-glucan.

Cluster 3, the smallest segment, consisted of young, well-educated females with high incomes. Beta-glucan source was the most important attribute for this group. They expressed a preference for beta-glucan sourced from barley (1.23) and marketed under a mainstream brand (0.39). This cluster was the least price sensitive and scored a utility of 0.24 for the highest priced bread. This was also the only cluster that considered the stabilisation of blood sugar levels as significant to the purchasing decision of a beta-glucan enriched bread (utility = 0.18).

Cluster 4 had slightly more male consumers who were married and in full-time employment between the ages of 25-54. Consumers in this age group were more likely to have more than one child residing at home and had a varied net income. This cluster was the most adverse to a bread marketed under a mainstream brand and were the only cluster to show a preference for a specialty branded bread (0.14), sold at the price of €2.60 per 550g loaf (utility = .05).

A significant, and a very significant relationship, between gender and increased motivation to purchase a product that displayed a health claim was evident in Cluster 1 ($p \leq 0.05$) and Cluster 3 ($p \leq 0.001$) respectively. In both groups, females were far more likely to purchase a product which displayed a health or nutritional claim.

**Table 3 Socio-demographic Profiles of Individual Clusters**

| Socio-demogrpah. | Factor (%) | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|---|
| **Gender** | Male | **50** | **38** | **38** | **57** |
| | Female | **50** | **62** | **62** | **43** |
| **Age Group** | 18-24 | **29** | **25** | **19** | **16** |
| | 25-34 | **32** | **20** | **43** | **28** |
| | 35-44 | **15** | **18** | **33** | **24** |
| | 45-54 | **19** | **25** | **5** | **22** |
| | 55-64 | **2** | **4** | **0** | **9** |
| | 65+ | **3** | **8** | **0** | **1** |
| **Education Level** | No formal | **2** | **1** | **0** | **2** |
| | Primary | **3** | **7** | **0** | **3** |
| | Secondary | **27** | **20** | **43** | **31** |
| | Tertiary | **68** | **72** | **57** | **64** |
| **Marital Status** | Single | **46** | **35** | **33** | **30** |
| | Married | **42** | **51** | **43** | **57** |
| | Separated | **2** | **5** | **0** | **2** |
| | Co-habiting | **9** | **9** | **24** | **9** |
| | Widowed | **1** | **0** | **0** | **2** |
| **Occupational Status** | Full-time | **52** | **44** | **67** | **65** |
| | Part-time | **9** | **11** | **14** | **6** |
| | Student | **24** | **18** | **10** | **13** |
| | Retired | **3** | **6** | **0** | **5** |
| | Other | **12** | **21** | **9** | **11** |
| **Household Net Income** | Less than €199 | **4** | **5** | **0** | **6** |
| | €200-€399 | **9** | **14** | **10** | **14** |
| | €400-€599 | **17** | **17** | **24** | **10** |
| | €600-€799 | **15** | **13** | **5** | **10** |
| | €800-€999 | **6** | **3** | **10** | **14** |
| | More than €1000 | **17** | **24** | **33** | **21** |
| | Decline to answer | **32** | **24** | **18** | **25** |
| **Incomes per Household** | One | **46** | **53** | **33** | **43** |
| | Two | **45** | **38** | **67** | **50** |
| | More than two | **9** | **9** | **0** | **7** |
| **Children per Household** | None | **54** | **49** | **43** | **45** |
| | One | **9** | **10** | **24** | **15** |
| | Two | **14** | **18** | **14** | **19** |
| | More than two | **23** | **23** | **19** | **21** |
| **Area of Residence** | Urban | **25** | **28** | **24** | **22** |
| | Suburban | **55** | **44** | **62** | **53** |
| | Rural | **20** | **28** | **14** | **25** |
| **Attribute** | **Level** | **Cluster 1** | **Cluster 2** | **Cluster 3** | **Cluster 4** |
| **Brand** | Mainstream | **0.16**** | **-0.07** | **0.39**** | **-0.35*** |
| | Specialty | **-0.2*** | **-0.14*** | **-0.42*** | **0.14** |
| | Co-brand | **0.04** | **0.21**** | **0.03** | **0.20**** |
| **Description** | Gluten-free | **-0.04** | **-0.01** | **-0.25*** | **0.17** |
| | Health loaf | **-0.11*** | **-0.06*** | **0.15**** | **0.24**** |
| | Low-allergen | **0.15**** | **0.08**** | **0.1** | **-0.41*** |
| **Beta-glucan Source** | Oats | **0.16**** | **0.12**** | **1.17** | **0.05** |
| | Barley | **0.06** | **-0.11*** | **1.23**** | **0.06**** |
| | Seaweed | **-0.22*** | **-0.01** | **-2.4*** | **-0.12*** |
| **Health/Nutritional Claim** | Reduce risk of cardiovascular disease | **0.07** | **-0.01*** | **0.01** | **-0.05** |
| | Reduce cholesterol levels | **0.08**** | **0.02**** | **-0.19*** | **0.25**** |
| | Stabilisation of blood sugar levels | **-0.14*** | **-0.01*** | **0.18**** | **-0.2*** |
| **Price** | €1.90 per 400g loaf | **0.45**** | **0.17**** | **-0.46*** | **-0.03*** |
| | €2.60 per 550g loaf | **0.07** | **0.08** | **0.22** | **0.05**** |
| | €3.70 per 800g loaf | **-0.51*** | **-0.24*** | **0.24**** | **-0.02** |
| **Bread-type** | White high fibre | **0.39**** | **-2.46*** | **0.16**** | **-0.56*** |
| | Wholesome wholegrain | **-0.12** | **1.18** | **-0.11*** | **0.17** |
| | Wholemeal brown | **-0.26*** | **1.28**** | **-0.04** | **0.40**** |
| **No. of Consumers** | Per cluster | **117** | **71** | **21** | **88** |

**Notes *The lowest utility values represent less value from the purchaser's perspective;**
****The highest utility values represent more value from the purchaser's perspective**

## 3.3 Simulation Analysis

Through the use of utility values, the optimal preferences for each cluster were identified and specifically focused on the optimisation of the product design formulations for the simulation analysis. Table 4 shows the optimal beta-glucan enriched products based on individual utilities per cluster generated from the K-means Cluster Analysis. These new product designs were then used in the simulation analysis to derive preferences for each product.

**Table 4 Optimal Product Design Attributes per Cluster**

| | ***BEGLU BREAD 1*** | ***BEGLU BREAD 2*** | ***BEGLU BREAD 3*** | ***BEGLU BREAD 4*** |
|---|---|---|---|---|
| **Attributes** | **Cluster 1** | **Cluster 2** | **Cluster 3** | **Cluster 4** |
| **Brand** | Mainstream | Co-branded | Mainstream | Co-branded |
| **Description** | Low-allergen | Low-allergen | Health loaf | Health loaf |
| **Beta-glucan source** | Oats | Oats | Barley | Barley |
| **Health/Nutr. claim** | Reduce cholesterol | Reduce cholesterol | Stabilisation of blood sugar levels | Reduce cholesterol |
| **Price** | €1.90 per 400g | €1.90 per 400g | €3.70 per 800g | €2.60 per 550g |
| **Bread-type** | White high fibre | Wholemeal brown | White high fibre | Wholemeal brown |
| **Preference Score** | **6.8** | **7** | **7.3** | **7** |

To further understand the importance of particular product design attributes for specific clusters and to reveal more detailed information on the tradeoffs consumers within individual clusters were willing to make, a number of hypothetical simulations, other than the optimal BEGLU breads were examined. These BEGLU bread profiles were specific to each cluster and ranged from BEGLU Bread 5 to BEGLU Bread 30.

The conjoint model predicted that Cluster 1 would most prefer BEGLU Bread 1 (mean score of 6.8/9) (See Table 4). Seven extra hypothetical beta-glucan enriched bread concepts (BEGLU Bread 5-11) were originally included in the simulation for Cluster 1 to determine the tradeoffs consumers within Cluster 1 were willing to make. These additional beta-glucan bread profiles were slight variants of BEGLU Bread 1. It was found that although consumers had a preference for a bread marketed under a mainstream brand (Table 4), a high predicted preference score was also evident for bread which was co-branded (preference score of 6.6/9). Consumers in this group were also willing to purchase a barley enriched beta-glucan bread provided it was offered at the lower price (preference score of 6.7/9). Although this group was the most price-sensitive, consumers in this group were willing to make tradeoffs between price and bread-type. Consumers were willing to pay up to €2.60 per 550g loaf of bread provided that the bread was white. However, they would only pay the lowest price for a bread which was wholegrain brown. For example, it was predicted that Cluster 1 would choose BEGLU Bread 8 (mean preference score of 6.2/9) over BEGLU Bread 9 (mean preference score of 5.8/9) due to sensitivity to increased price. The preference scores and both the probability and Logit models indicated that the consumers from Cluster 1were willing to compromise on price up to a certain point in relation to bread-type, in this case the price of €2.60 per 550g per loaf.

The group level simulation predicted that Cluster 2 would most prefer BEGLU Bread 2 (mean preference score of 7.0/9). Five further variants of BEGLU Bread 2 were used in the simulation analysis (BEGLU Breads 12 – 16). The results revealed that consumers were not very price sensitive. This was evident by the high scores for BEGLU Bread 12 and BEGLU Bread 13. Each of these products varied from the optimal BEGLU Bread 9 by price level, an increase from €1.90 per 400g to €2.60 per 550g (mean preference score of 6.9/9) and from €1.90 per 400g to €3.70 per 800g (mean preference score of 6.6/9) respectively. It was evident that consumers were willing to make tradeoffs between price and bread-type evident by the low score (3.0) associated with BEGLU Bread 14, a white variety of the optimal BEGLU Bread 24.

The optimal product for Cluster 3 was identified as BEGLU Bread 3 (See Table 4). This bread marketed the health claim concerning the stabilisation of blood sugar levels. The K-means Cluster Analysis previously revealed that this group were the least price sensitive of the four clusters. Six further hypothetical variants of the optimal BEGLU Bread 3 were run in the simulation analysis to determine what tradeoffs, if any, consumers would make between various attributes, particularly price

and health /nutritional claim (BEGLU Breads 17 - 22). It was found that Cluster 3 allocated an equally high preference score (7.3/9) to the variant BEGLU 19. This revealed that Cluster 3 believed the difference between a bread marketed as a health loaf or as a low-allergen loaf as insignificant in the purchase of a beta-glucan enriched bread. Further analysis also revealed that although barley beta-glucan was preferred by individuals within Cluster 3, the use of oat beta-glucan in BEGLU Bread 20 also scored a very high preference score (7.2/9). Due to a preference for an increased price, Cluster 3 was willing to make tradeoffs between price and health claim. It was found that consumers of Cluster 3 would accept the lowest price/portion size for a bread that claimed to have an effect on blood sugar levels. This was evident in the high preference score (7.2/9) allocated to BEGLU Bread 20 which consisted of a white bread which carried a claim related to blood sugar levels priced at €1.90 for a 400g loaf. This was in comparison to BEGLU 22 which was a white bread which marketed a health claim related to cholesterol reduction and was also at the lowest price/ portion size (mean preference score 6.2/9).

An analysis of the simulation models developed for Cluster 4 (BEGLU Breads 23 - 30) made it possible to determine that this group of consumers was not willing to make tradeoffs between price and bread-type, evident by the allocation of low preference scores (5.4/9, 5.8/9 and 5.9/9) for all BEGLU Breads described as white. The high preference score allocated to BEGLU Bread 32 (7.0/9) revealed that motivation to purchase a beta-glucan enriched bread would not be affected by a change in the source of beta-glucan from oats to barley. Brand was an important attribute motivating the purchase of a beta-glucan enriched bread for this specific group of consumers and unsurprisingly, tradeoffs between brand and price were evident. BEGLU Bread 25 differed from the optimal BEGLU Bread 22 in that it retailed at a lower price. The comparison of two variants, BEGLU Bread 25 (mean preference score of 6.9/9) and BEGLU Bread 29 (mean preference score of 6.9/9) indicated that a change in the price of a co-branded, wholemeal beta-glucan enriched bread from €2.60 per 550g to either the highest or the lowest price/portion size would not impact greatly on Cluster 3's willingness to purchase a beta-glucan bread. However, the probability models suggested that the price of the €3.70 per 800g loaf would be slightly favoured. Due to the importance of brand in the purchasing decision, it was also unsurprising that all simulation profiles marketed under a mainstream brand received a lower preference score and consumers still preferred the price of €2.60 per 550g.

# 4. CONCLUSIONS

The NPD literature emphasises the necessity for market-oriented methodologies which integrate the consumer during the early stages of the NPD process. This research focused on the incorporation of the voice of the consumer (VOC) throughout the product concept stage, therefore, increasing overall consumer acceptance of a novel bread product. This allowed for the development of a streamlined supply chain designed to meet consumers' demand for a novel beta-glucan product. The focus groups and interviews outlined the needs and expectations consumers had for a novel functional ingredient and were essential to guide and refine the hypothetical beta-glucan enriched bread concepts at the early stages of the NPD process. Such a market-oriented approach encouraged frequent communication between partners within the supply chain, thus ensuring all partners were aware of any changes which could be made in the early stages of the NPD process to increase overall consumer acceptance of a beta-glucan enriched product. Issues affecting low confidence levels towards functional foods, health claims and foods marketed as healthy, allowed for an in-depth knowledge of the factors which affected the purchase of functional bread products. The application of this knowledge to the conjoint study was pivotal in the determination of optimal product attributes for a beta-glucan enriched bread.

Age impacted upon consumers' willingness to consume novel functional foods and beverages. Although consumers in older age categories were more motivated to seek out health benefits provided by foods, they were also least encouraged to purchase novel functional foods [70, 71]. Communication of the health benefits of beta-glucan enriched bread should be specific and easily understood by the target market. A large variation in the perceived and self-estimated intake of fibre encouraged consumers to believe that they were meeting sufficient RDAs for fibre. Although a common finding in other studies this finding has the potential to impact upon consumers' willingness to purchase a fibre enriched food [72,73]. Convenience was a key trend considered by consumers. Consumers were very receptive towards enrichment or fortification of bread products which would increase the healthiness of their personal diet and/or the diet of their family, with minimal effort. An efficient knowledge management process that would inform and educate consumers about fibre-rich foods, RDAs and health benefits could have a

positive impact on the acceptance of a novel fibre-enriched product. A beta-glucan enriched bread could replace a less functional bread product and increase the fibre intake of the diet in a convenient way.

An analysis of the utility values associated with certain clusters varied from the utility values calculated for the sample as a whole. Although no significant relationships existed between bread-type consumed and socio-demographic information, it was evident from the results of the K-means analysis that particular groups of consumers held a distinct preference for white or brown bread. Through the effective use of knowledge management within the NPD process, the optimal product design concepts derived for each cluster and outlined above can be utilised by developers to manufacture a novel market-oriented beta-glucan enriched bread which targets the current needs and requirements of specific clusters of consumers. The design of these market-oriented concepts can aid in the development of an efficient and responsive supply chain, one which provides novel innovative food and beverage products which reflects consumers' demands. Through the use of the K-means Cluster Analysis, it was evident that both Cluster 1 and Cluster 2 offered commercial potential for product developers of beta-glucan enriched breads. However, the high price sensitivity displayed by respondents in Cluster 1 and their preference for the lowest price/portion size meant that Cluster 2 would offer increased opportunities to product developers. This cluster contained a large proportion of female consumers who were keen to improve the healthiness of their diet and the diet of those around them. The simulation analysis and probability models also revealed key tradeoffs and important information that allowed for the identification of a bread that would maximise consumer interest across a number of clusters. A bread which was wholemeal brown and enriched with oat beta-glucan, marketed under a co-brand, and described as a health loaf which had a positive impact on cholesterol levels would target not just consumers within Cluster 2 but also in Cluster 3 and Cluster 4. This would increase the likelihood of success for product developers.

Conjoint Analysis was successful in illustrating the various tradeoffs consumers would make between various beta-glucan enriched breads. Its utilisation allowed for the prioritising of product attributes according to consumers' preferences and helped drive the NPD process. The generation of market segmentation information allowed for the development of a beta-glucan enriched bread which catered specifically to a segment of consumers from a specific socio-demographic background, with particular attitudes and consumption needs. The identification of the optimal product attributes through the use of the Conjoint Analysis methodology ensured that a market-oriented approach was central to the development of a novel beta-glucan enrich bread. The information generated in this research can be used to inform the design and development of novel beta-glucan enriched products that will maximise overall consumer acceptance and enable firms to develop and launch more successful products.

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