Development of a model to predict consumer acceptance of cottage pie from sensory quality and salt content

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Background

- Within the UK, salt consumption is well above recommended values for sodium intake and poses great risk to health.
- The greatest proportion (75 - 80%) can be attributed to processed foods (IFST, 1999).
- The COMA Report and the Food Standards Agency have recommended a reduction of 30% in dietary salt intake (DOH, 1991; FSA, 2002).

Industrial Problem - Research Aim

- Reducing salt in processed foods can potentially lead to loss of flavour, texture, product yield and eventual loss of revenue.
- The AIM of this preliminary study was to develop a model to predict consumer acceptance from sensory quality and (reduced) salt content.

Methodology

- **8 samples (0.67% - 0%) of processed cottage pie.**
- Trained QDA panel **(n=10) :**

- **used to evaluate the effects of a reduction in salt on sensory characteristics;**
- **samples evaluated in triplicate using a balanced block design.**

- Consumer panel (9-point Hedonic scale) **(n=80):**

- **used to evaluate the acceptance of samples;**
- **samples evaluated once in random order.**

Statistical Analysis
External Preference Mapping

- A Principal Component Analysis was applied to the 15 sensory attributes extracting 3 PCs that explained 56.5% of the variance in the data
  - PC1 represented a "salt" dimension
  - PC2 represented "flavour and quality"
  - PC3 represented an "aroma and sauce consistency" dimension
- Linear regression was used to predict acceptance, Y, for each consumer in terms of sensory PCs
  - $Y = b0 + b1.PC1 + b2.PC2 + b3.PC3$

Introducing Added Salt to the Model

- PC1 was strongly associated with added salt (r=0.990) and so a second linear regression was done to relate PC1 to added salt, X
  - PC1 = a + b.X
- This was substituted into the model for Y
  - Y = a' + b1'.X + b2.PC2 + b3.PC3
  - where a' = b0+b1.a and b1' = b1.b
- There were wide variations for all 4 regression coefficients

Statistical Analysis

- An exploratory hierarchical cluster analysis produced a dendogram that was inspected leading to a decision to use 4 clusters
- Hierarchical cluster analysis applied to the regression coefficients of the extended model. Used to highlight clusters of consumers whose acceptance was related to salt and sensory quality in different ways.
- Series of ANOVAs including cluster as a between subjects effect to reveal significant differences between clusters.

Results

The Consumer Clusters

- Cluster 1 (n=26) characterised by preference for low flavour and aroma
- Cluster 2 (n=14) characterised by preference for high flavour and aroma
- Cluster 3 (n=36) not as sensitive to sensory quality as clusters 1 and 2
- Cluster 4 (n=4) had largest increase in acceptance per unit added salt
- Cluster 1 is the only group for whom product acceptance decreases with added salt

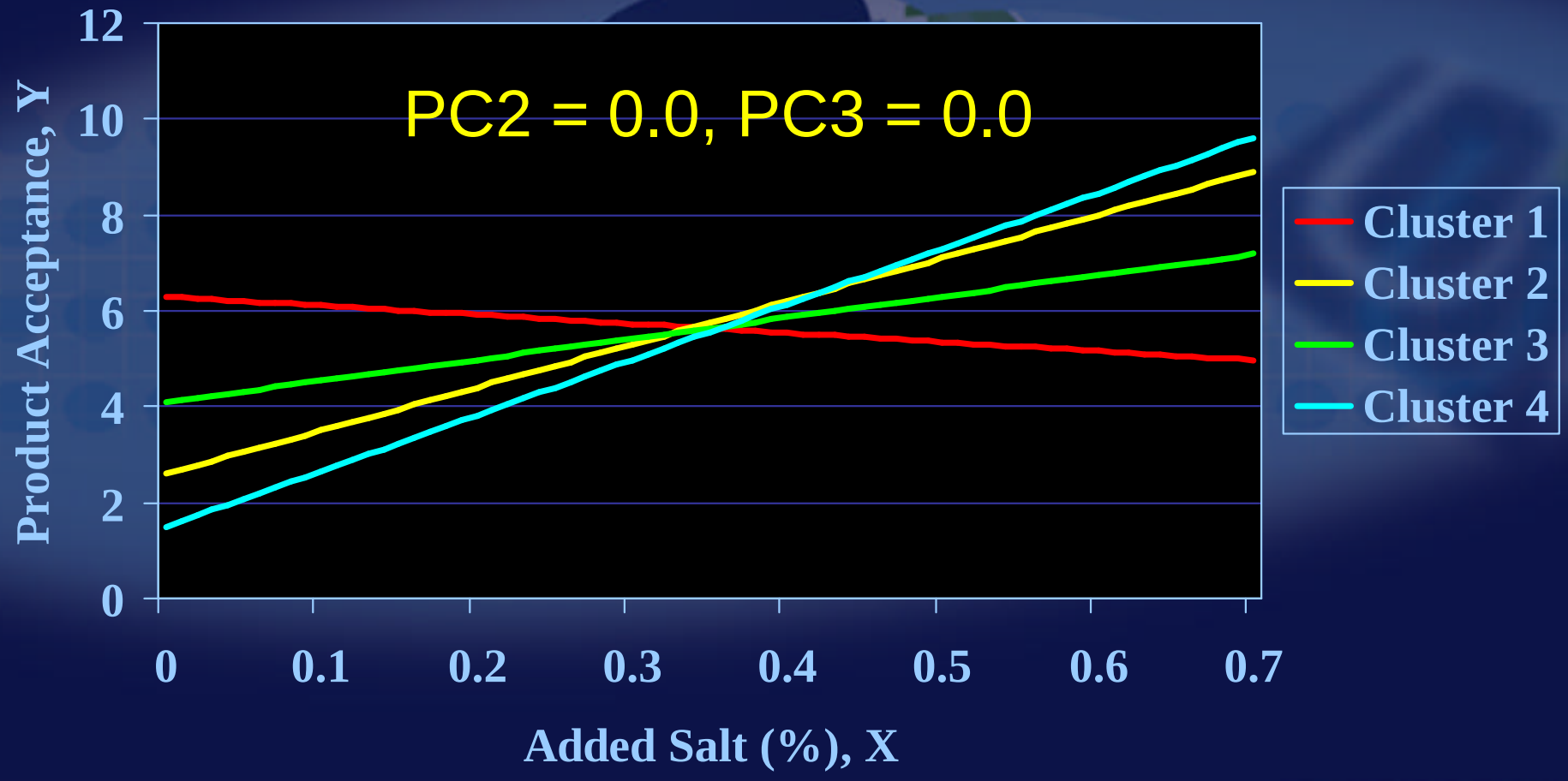
Results
Comparing the Clusters

Cluster	a’	b1’	b2	b3
1 (n=26)	6.3	-1.9	-5.9	-6.5
2 (n=14)	2.6	9.0	7.2	4.6
3 (n=36)	4.1	4.4	0.1	-1.9
4 (n=4)	1.5	11.6	13.6	12.7
F(3,76)	22.8^	49.7^	162.3*	115.9*

*** P<0.001 with Bonferroni post hoc tests revealing differences between each pair of clusters, ^P< 0.001 with Bonferroni post hoc tests revealing differences between each pair of clusters except 2 and 4.**

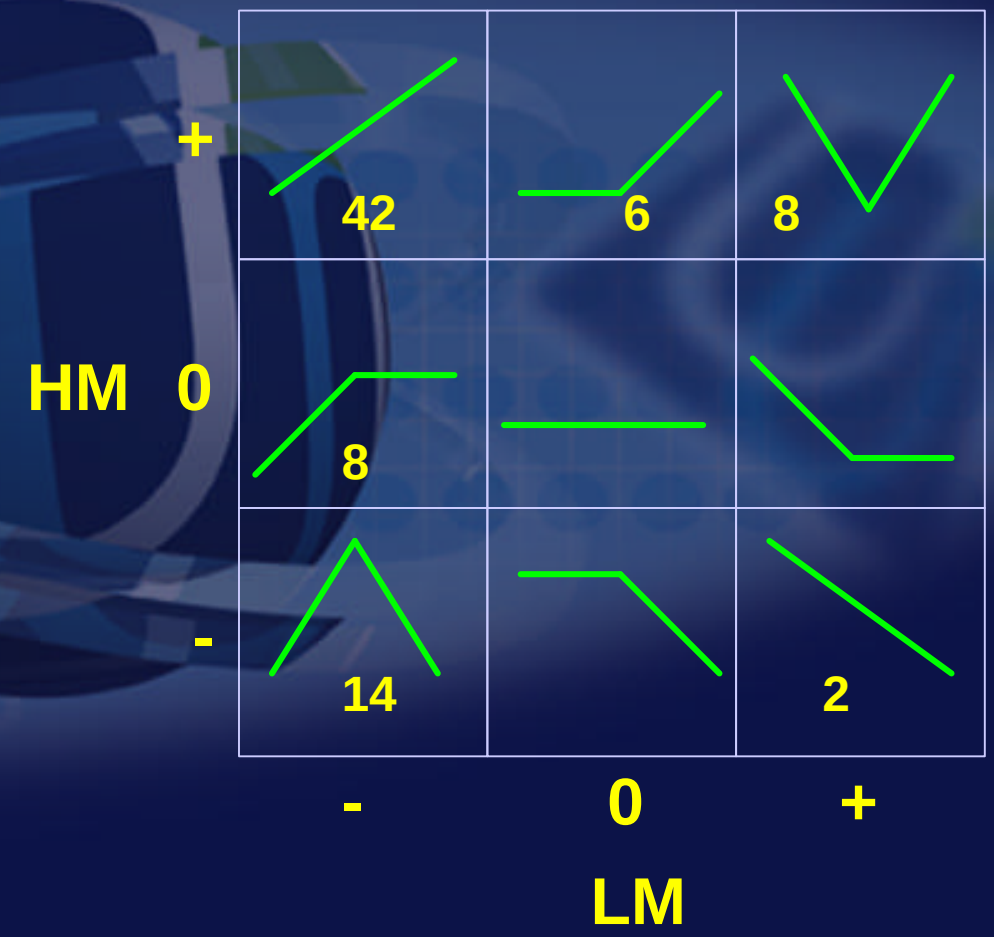
Results

The effect of added salt on product acceptance for an average product



Alternative Models that could have been used to analyse optimal added salt

- Linear models classify consumers into those for whom acceptance
  - improves with added salt
  - improves with reduced salt
- Future studies could compare acceptance of low salt and medium salt products (LM) as well as high salt and medium salt products (HM)
- This would allow those consumers preferring optimal added salt to be identified
- Only 14 out of 80 in current study



Conclusions and Implications

- Cluster Analysis, friedman ANOVA and Wilcoxon Signed Rank Test identified 0.47% added salt as optimum.
- Such predictive models may help food manufacturers:
  - reduce salt content effectively (& cost efficiently);
  - enhance product positioning strategies.
- Further work is required to validate the model for a range of product types.