# CONSUMER PREFERENCE
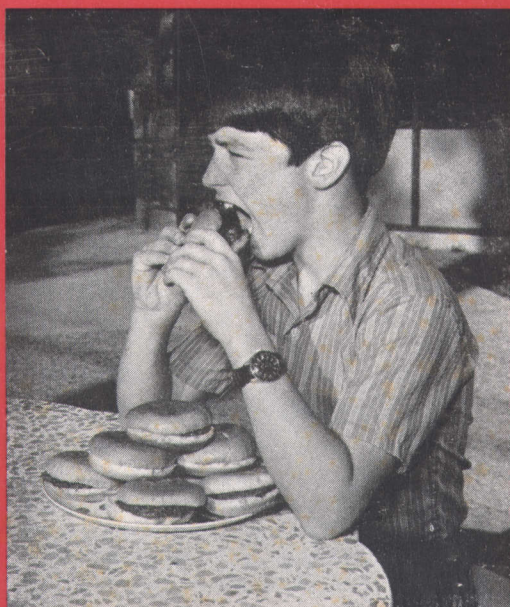## for Ground Beef
## As Reported By A Birmingham Taste Panel

## A METHODOLOGICAL APPROACH

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# Consumer Preference for Ground Beef as Reported by a Birmingham Taste Panel

## A Methodological Approach[1]

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## INTRODUCTION

The POPULATION of the United States increased 34 per cent between 1950 and 1970. During the same period per capita consumption of beef increased 80 per cent, Table 1. Consumption of pork in 1970 was approximately 4 pounds per person lower than in 1950. Per capita consumption of chicken increased by approximately 15 pounds from 1950 to 1970. Total per capita consumption of the three types of meat increased 62 pounds over the 20-year period. The increase in population plus the additional increase in per capita beef consumption required a substantial increase in cattle production.

Assuming a relatively fixed demand for food for a stable population, increased per capita consumption of one product implied a decreased per capita consumption of other products. Increased beef consumption represented an upgrading of diets from cereal products to meat as well as shifts within types of meat.

Within the per capita consumption of beef, 30 per cent was ground beef. Grinding the beef product represented a method of marketing, at a lower price, portions of the beef carcass that could not be sold as standard cuts.

This study was designed to determine consumer responses to ground beef with soya and three fat levels.

If vegetable additives and fat can be added to ground beef without invoking a negative buying response from consumers, a fixed amount of beef can be allocated to a larger number of consumers. Alternatively, if a negative buying response results, one might consider appropriate price differentials to move the product into market channels.

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## METHOD OF STUDY

A taste panel of 138 households was randomly selected from the population of Birmingham, Alabama.[3] The random sample was not representative of the State population. The household panels tested ground beef compositions of 15, 25, and 35 per cent fat. Each fat level was tested as 100 per cent ground beef and ground beef containing 2 per cent soya. The ground beef was randomly presented to the households such that each household received a different ground beef composition each week. Socio-economic data relating to each family were ascertained. The meat preferences and usage of ground beef by each household were determined from interviews.

Adult members of each household were requested to rate each ground beef product with respect to the taste qualities, tenderness, juiciness, fatness, flavor, and general liking. In addition, the housewife was requested to rate the cooking characteristics, raw and cooked color, aroma, shrinkage, and general cooking quality of each product. A nine-point hedonic scale was used in each rating.[4]

The results as reported by each member of the panel were combined into hedonic scaling distributions for each test product. The weighted average hedonic measurement was derived within socio-economic subdivisions. Subdivisions were made on the basis of who tested the product, employment status of the wife, and income level for the household. Since more than two mean values were involved in the experiment, analysis of variance tests were used.

TABLE 1. CIVILIAN POPULATION OF THE UNITED STATES AND PER CAPITA CONSUMPTION OF BEEF, PORK AND CHICKEN, SELECTED YEARS

| Year | Civilian population | Consumption per capita | | |
|------|---------------------|------|------|---------|
| | | Beef | Pork | Chicken |
| | Mil. | Lb. | Lb. | Lb. |
| 1950 | 151.3 | 63.4 | 69.2 | 26.4 |
| 1960 | 178.2 | 85.0 | 64.9 | 28.0 |
| 1965 | 191.9 | 99.3 | 58.5 | 33.3 |
| 1968 | 197.6 | 109.4 | 66.0 | 37.4 |
| 1969 | 199.7 | 110.5 | 64.8 | 39.0 |
| 1970[1] | 202.2 | 114.0 | 65.0 | 41.8 |

[1] Estimated Source: Handbook of Agricultural Charts, 1970 USDA Agricultural Handbook No. 397.

[3] See Appendix A for characteristics of the sample population.
[4] See Appendix B for description of the hedonic scale.

The weighted averages were fitted into a fully crossed factorial design with a selected socio-economic characteristic, fat levels, soya levels, and weeks as factors. Weeks were included *a posteriori* since a general trend towards higher hedonic ratings seemed apparent in later weeks of the experiment. Orthogonal contrasts were then fitted to those factors disclosed significant by analysis of variance.[5]

While the sample size was sufficient, the scope of the experiment was limited by location and composition of the household taste panel. General conclusions regarding Alabama must be constrained. The taste panel results were applicable to a wider area than Birmingham only to the extent that households in other areas were similar to Birmingham households.

## Meat Preferences of the Birmingham Taste Panel

Before receiving the ground beef products the panel members were questioned regarding preferred types of meat. Beef was rated as first choice by 80 per cent of the panel members, Table 2.

TABLE 2. TYPE OF MEAT PREFERRED BY BIRMINGHAM TASTE PANEL, 1968

| Meat type | Choice | | | Total |
|---|---|---|---|---|
| | First | Second | Third | |
| | Pct. | Pct. | Pct. | Pct. |
| Beef | 80 | 15 | 5 | 100 |
| Veal | ---- | 3 | 6 | 9 |
| Pork | 5 | 18 | 30 | 53 |
| Lamb | ---- | 3 | 3 | 6 |
| Chicken | 15 | 51 | 22 | 88 |
| Turkey | ---- | 2 | 4 | 6 |
| Fish | ---- | 8 | 30 | 38 |
| **Total** | 100 | 100 | 100 | ---- |

TABLE 3. TYPE OF BEEF PREFERRED BY BIRMINGHAM TASTE PANEL, 1968

| Beef cut | Choice | | | Total |
|---|---|---|---|---|
| | First | Second | Third | |
| | Pct. | Pct. | Pct. | Pct. |
| No answer | 1 | 1 | 1 | 3 |
| Liver | 5 | 7 | 7 | 19 |
| Stew meat | 4 | 8 | 23 | 35 |
| Bologna | 1 | 1 | 2 | 4 |
| Ground beef | 16 | 35 | 38 | 89 |
| Roast | 25 | 36 | 20 | 81 |
| Steak | 48 | 8 | 8 | 64 |
| Weiners | 0 | 4 | 1 | 5 |
| **Total** | 100 | 100 | 100 | |

[5] See Appendix C for the statistical methodology.

Chicken and pork were rated second and third with respect to first choice and for summation of the top three choices. Fish was the only other meat product to receive a significant preference.

As expected, steak was the meat preferred by half the panel. In second place a third of the panel chose ground beef or beef roast. However, in total choices, ground beef and beef roast were more popular than steak, Table 3.

Price may have been a factor in meat selection. Half or more of the homemakers said ground beef was less expensive than beef or pork roasts, and that chicken and fish were about the same cost on a per serving basis, Table 4. Slightly less than half thought hamburger cost less but chicken was more expensive per serving. About half said ground beef cost more than hamburger, but about the same number could not differentiate between the two products as shown below:

| Response | Percentage of panel |
|---|---|
| Products are different | 47 |
| Products are the same | 40 |
| Do not know | 13 |

Steak was the preferred meat and would be used when price was ignored, as for a prestige meat. However, beef roast or

TABLE 4. COMPARISON OF COST PER SERVING OF GROUND BEEF WITH SELECTED OTHER MEATS BY BIRMINGHAM TASTE PANEL, 1968

| Comparison, ground beef price with selected product | Type of meat | | | | |
|---|---|---|---|---|---|
| | Beef roast | Pork roast | Chicken | Hamburger | Fish |
| | Pct. | Pct. | Pct. | Pct. | Pct. |
| Higher cost | 6 | 10 | 43 | 53 | 28 |
| Same cost | 14 | 30 | 48 | 42 | 48 |
| Lower cost | 79 | 59 | 8 | 4 | 22 |
| No answer | 1 | 1 | 1 | 1 | 2 |
| Total | 100 | 100 | 100 | 100 | 100 |

TABLE 5. COMPARISON OF CONSUMER PREFERENCE BETWEEN GROUND BEEF AND SELECTED OTHER MEAT BY THE BIRMINGHAM TASTE PANEL, 1968

| Type of meat | Consumer preference for ground beef | | | | Total |
|---|---|---|---|---|---|
| | Like better | Like same | Like less | No answer | |
| | Pct. | Pct. | Pct. | Pct. | Pct. |
| Steak | 22 | 17 | 59 | 2 | 100 |
| Beef roast | 27 | 24 | 47 | 2 | 100 |
| Pork chops | 56 | 30 | 12 | 2 | 100 |
| Pork roast | 70 | 21 | 7 | 2 | 100 |
| Hams | 41 | 51 | 7 | 1 | 100 |
| Chicken | 30 | 54 | 15 | 1 | 100 |
| Fish | 57 | 30 | 12 | 1 | 100 |
| Lamb | 85 | 7 | 7 | 1 | 100 |

ground beef were acceptable when budget or usual menu patterns take over.

Half or more of the respondents liked ground beef more than lamb, pot roast, fish, and pork chops. About half liked ground beef less than steak or beef roast. About half liked ham or chicken about the same as ground beef, Table 5.

Either ground beef or hamburger was served in all households at least once a week, and an average of three meals a week included a ground meat dish. Hamburger steak, meat loaf, meat balls, and sauce were also popular uses, Table 6.

Average per capita consumption of ground beef per serving for panel households was approximately one-fifth of a pound. If the same ground beef consumption held true for the entire State population, increases or decreases by one serving per year would result in a total consumption change of approximately 700,000 pounds of ground beef in Alabama.

Fresh or red color was the most important characteristic these women looked for in purchasing ground beef since three-fourths of them mentioned this attribute in some form. Only 14 per cent considered low fat and five per cent price as important in selection of ground beef. Control of factors affecting the appearance of the product could increase sales so long as the price did not radically change. Improvements in color and lowering the apparent fat content might also appreciably change demand for the product.

Half the respondents did not like the level of fat in ground beef they purchased. A fourth said they liked fat in ground beef for flavor. The remainder disliked the fat level in purchased ground beef because of waste, or for health reasons.

TABLE 6. FREQUENCY OF SERVING SELECTED TYPES OF GROUND BEEF DISHES BY BIRMINGHAM TASTE PANEL, 1968

| Type of dish | Frequency of serving | | | | Total |
| --- | --- | --- | --- | --- | --- |
| | Once per week | Once per month | Few | Never | |
| | Pct. | Pct. | Pct. | Pct. | Pct. |
| Ground beef | 98 | 2 | 0 | 0 | 100 |
| Hamburger | 96 | 4 | 0 | 0 | 100 |
| Hamburger steaks | 41 | 17 | 4 | 38 | 100 |
| Meat loaf | 22 | 54 | 14 | 10 | 100 |
| Chili | 2 | 16 | 26 | 56 | 100 |
| Meat balls | 10 | 28 | 14 | 48 | 100 |
| Meat casserole | 2 | 9 | 9 | 80 | 100 |
| Meat sauce | 13 | 42 | 7 | 38 | 100 |

## ANALYSIS OF PANEL RATINGS OF GROUND BEEF

### Cooking Characteristics

The panel households were presented six different ground beef products over a 6-week period. The homemaker was asked to rate each product on five selected cooking characteristics: raw color, aroma, shrinkage, cooked color, and general quality. Analysis was made on the bases of employment and nonemployment of homemakers outside the home and income class.

Working wives rated the ground beef product less favorably for raw color and aroma characteristics than the non-working wives. Employment status was not related to ratings for cooked color and general quality of the product. Both groups considered shrinkage excessive.

Increase in fat content decreased the ratings for all cooking characteristics except cooked color. The 35 per cent fat content was rated more favorably for shrinkage than the 25 per cent fat, but both levels were rated lower than the 15 per cent fat level.

As the level of fat increased, ratings for the attractiveness, color, aroma, and general quality of the ground beef product declined. The panel preferred the 15 per cent fat level; however, if this level was exceeded there was little apparent difference between the preference for 25 per cent and 35 per cent fat with respect to shrinkage.

The general cooking quality of the ground beef declined with an increase in fat content. The 35 per cent fat product was rated almost a full hedonic point less favorably than the 15 per cent fat product. The preference for low fat content implied that ground beef with lower fat could command a premium price or, could constitute a favorable advertising point.

The panel was unable to discern differences in cooking characteristics at the 2 per cent level of soya. Considering only cooking characteristics, the additions of soya up to the 2 per cent level apparently would not influence consumer preference for the product.

The rating of higher fat levels was less favorable after several weeks than was expected because of changes in fat level alone. Persons receiving the high fat product in early weeks of the experiment did not have a low fat test product for comparison. In later weeks the high fat product followed products with lower fat levels and the unfavorable rating increased. To expand to the marketing sector, a high fat product could be marketed if no low fat product was available as a standard of comparison.

There were significant differences for all treatment groups except soya levels where no rating differences by income level were evident.

As income level increased product favorability rating decreased. Since the hedonic scaling was comparative, this indicated higher income groups had a higher product standard as a base. In effect the same ground beef product rated by two different income groups received different ratings. Higher income groups did not like and probably did not use ground beef as much as lower income groups.

Panel ratings for fat levels by income were similar to ratings within the wife status subdivision. All characteristics were rated less favorably as the fat content was increased.

Both raw color and cooked color were rated less favorably over time. The change in each was quite similar. The products were prepared before the experiment began. The first products received by the panel had been in cold storage the least amount of time. The raw color of the product could have changed over time in storage, and this might have had a direct effect on cooked color also, thereby affecting ratings.

## Taste Characteristics

Taste characteristics of the six ground beef products were rated by all family members over 12 years of age. There was a significant difference in taste ratings between persons for flavor and general liking. The fat level influenced ratings for fatness, juiciness, and general liking.

The product containing 2 per cent soya was rated above the non-soya ground beef in juiciness. Since there was no apparent difference in rating based on other taste characteristics, the inclusion of soya at the 2 per cent level could result in a superior product. Storage apparently did not appreciably change the juiciness of the product even though the flavor, tenderness, fatness and general liking ratings all declined over time.

"Other" persons usually children, in the family, rated the ground beef product most favorably with regard to flavor and general liking. The husband rated the product least favorably. There was no significant difference in the general liking rating between the husband and wife.

The 15 per cent fat level was the most favorably rated for the fatness characteristic, however this may have been more fat than

was desired in ground beef by the panel. Other panel tests indicate 25 per cent is an acceptable level.[6]

The lower income group rated the products most favorably with respect to tenderness and juiciness. This result agreed with the ratings of cooking characteristics by respondents at high and low income levels. The fatness characteristic changed more than proportionately with movement from one level to the next. An increase in fat level from 25 to 35 per cent caused a greater change in preference than a change from 15 to 25 per cent.

Certain general conclusions were drawn from analysis of panel ratings of taste characteristics. First, soya at the 2 per cent level did not adversely affect the flavor of the product and increased the juiciness. Second, the lower fat levels were most acceptable with the highest fat level receiving very unfavorable rating. Third, the first products received by the panel received higher ratings than later products indicating product quality may have deteriorated in storage or that initial responses should be discounted.

## SUMMARY

In 1968 a panel of 138 families in Birmingham, Alabama was given ground beef of six different compositions over a 6-week period. This beef included 0 and 2 per cent soya in combination with 15, 25, and 35 per cent fat. Analysis was made by employment status and income. The housewife rated the product for cooking qualities, raw and cooked color, shrinkage, and general cooking characteristics. Each family member over 12 years of age rated the product for the taste characteristics such as tenderness, juiciness, fatness, flavor, and general liking.

The presence or absence of soya did not influence the panel rating except that children rated the cooked product with soya more favorably for juiciness.

Employed homemakers rated all products less favorably than other respondents. Ratings for cooking characteristics, raw color and aroma, were lower when homemakers worked away from home. Raw and cooked color were more highly related to general quality by employed homemakers. They were also more critical of higher levels of fat content.

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[6] Huffman, D. and W. E. Powell. Dec. 1970. "Fat Content and Soya Level Effect on Tenderness of Ground Beef Patties." Food Technology. Dec. 1970. Vol. 24, p. 100.

Low income homemakers rated all products more favorably than those of higher income in tenderness, juiciness and general liking. The 15 per cent fat level was preferred by most respondents because of less shrinkage in cooking, and ratings declined as fat level increased.

Children rated the cooked product most favorably for flavor and general liking, the husband the least favorably. Children so strongly related flavor to general liking that both factors could be considered synonymous. The primary determinants of overall liking were flavor and tenderness.

## CONCLUSIONS

Since the added soya did not affect ratings for either cooking or taste characteristics, it offers possibilities as a protein food extender. If Alabama consumption of ground beef approximated nationwide annual consumption of over 30 pounds per capita, the available beef supply could be increased by two million additional pounds by the use of soya material. The flavor and nutritive value of the product would be enhanced, and addition of soya might also reduce cost to the consumer.

The 15 per cent fat level was preferred over the higher levels. Cooking shrinkage and fat residue in the product as served were considered excessive at the 25 and 35 per cent fat level. Respondents with low income not employed outside the home were more tolerant of fat content than those of higher income or outside employment. A choice might be given the consumer through a lower priced product with higher fat content.

Only 2 per cent of the panel members had ever purchased frozen ground beef. Whether it was not available or the consumer preferred fresh ground beef was not determined. Ratings may have been influenced by color and flavor changes in the beef which had been frozen before the study began.

It is suggested that future research in this area would yield more conclusive results by the use of: only freshly ground beef, uniform cooking methods, a trained panel with characteristics representative of urban population in race, income, age and other pertinent attributes, and additives other than soya. Methods of analysis used in this study should also be further tested to acquire competence in techniques related to consumer acceptance.

## APPENDIX A

CHARACTERISTICS OF THE SAMPLE POPULATION, GROUND BEEF STUDY,
138 FAMILIES IN BIRMINGHAM, ALA. TASTE PANEL, 1968

| Item | Proportion of respondents |
|------|---------------------------|
| | *Per cent* |
| **Husband's occupation** | |
| Professional | 5 |
| Sales | 4 |
| Craftsman | 17 |
| Operative | 13 |
| Service | 7 |
| Clerical | 1 |
| Laborer | 6 |
| No answer or no husband | 47 |
| **Wife's occupational classification** | |
| Housewife | 55 |
| Works outside home | 27 |
| No answer or no wife | 18 |
| **Wife's level of education completed** | |
| None | 14 |
| Grade school | 44 |
| High school | 30 |
| Some college | 8 |
| College graduate | 3 |
| Not reported | 1 |
| **Wife's age (years)** | |
| 20-29 | 9 |
| 30-39 | 22 |
| 40-49 | 23 |
| 50-59 | 17 |
| 60 and over | 28 |
| Not reported | 1 |
| **Race** | |
| White | 38 |
| Non-white | 62 |
| **Adults in household (number)** | |
| 0 | 1 |
| 1 | 17 |
| 2 | 64 |
| 3 | 16 |
| 4 | 1 |
| 5 | 1 |
| **Family income distribution** | |
| Low (Below $5,000) | 62 |
| Medium ($5,000-$9,000) | 25 |
| High ($10,000 and over) | 6 |
| Not reported | 7 |

## APPENDIX B

### The Hedonic Scale

Hedonic was defined as "having to do with pleasure." Use of the hedonic scale was an attempt to quantify the pleasure derived from some good or service. The scalar measure was subjective in that each person attempted to define his own degree of pleasure.

The hedonic scale was ordinal. Statements regarding "greater than" or "less than" could be made. The values could be ranked. By the use of certain heroic assumptions parametric statistics were used with hedonic scales. The more important of these assumptions included: (1) the scalar values were the same for all users. This implied that each user had the same point of reference as a base point. (2) The absolute difference between consecutive scalar values was the same no matter where these values were located on the scale. This assumption implied the same amount of pleasure was represented between point seven and point eight as between point one and point two.

These assumptions were necessary if means, or F values were to be derived.

The hedonic scale was inverse. The higher the rating the less the individual liked the product.


## APPENDIX C

### The Analysis of Variance

Analysis of variance (ANOV), as the name implies, is a procedure whereby the variances of experimental treatment units are compared. The basis of the test is the relationship of the variance between treatments compared to the variance within treatment units. ANOV and "t" tests are directly related. The F Statistic of the ANOV equals $t^2$ at 1 and n degrees of freedom. The F test was used for more than two treatments whereas the t test was only usable for two treatments.

Various methods have been developed to assist in extracting the pertinent data from an ANOV table. Most of these methods are grouped into experimental designs. An experimental design is determined by the researcher on the basis of knowledge regarding the experimental material.

A factorial blocking experimental design was used in analyzing the consumer panel data. Persons, wife status or income was used as blocks and fat and soya levels as treatments. Blocking allowed

the measurement and removal of extraneous sources of error for additional precision in analyzing treatment effects.

When more than two factors are incorporated into the same experimental design, additional information can be extracted. An interaction term may be present. Interaction is the relationship between the several levels of the different factors.

The experimental design when fully crossed, i.e., all treatments are replicated over all blocks, can be analyzed for factor main effects and interactions. Since several levels of a factor were present they were further subdivided to determine the direction and slope of the treatment effect.

After the blocks or treatments were specified in equal intervals, orthogonal contrasts and orthogonal polynomials were fitted to the data to assist in analysis. The conceptual methodology of extractive analysis of hedonic scalar measurements is given in the table in Appendix C.

The error term was determined by subtraction. The summation of the sums of squares of the sub classifications equals the total sum of square. The error degrees of freedom were determined in the same manner. The example was based on an assumption of no interaction between treatment factors and blocks. The treatment effects were assumed fixed and were tested by the error mean square. If the treatment factors were random, the interaction term would constitute the proper comparative measure.

The null hypothesis was used in testing significance. The null hypothesis H:0 asserted there were no significant differences between treatment levels. Rejection of the null hypothesis indicated a treatment difference existed. The relationship within the significant variables was tested further by fitting orthogonal contrasts to the mean values. By definition $C_M$ was a contrast if:

$$N_j \ C_{jm} = 0$$

$C_m$ and $C_q$ were orthogonal contrasts if:

$$NC_{jm} \ C_{jq} = 0$$

The sum of squares of such contrasts were given by:

$$SS_{cj} = \frac{(C_m)^2}{N_j \ C^2_{jm}}$$

Since the relationship of the variables was established at a significant level, it was appropriate to determine the direction and magnitude of effect. Orthogonal polynomials were used to determine a regression equation.

$$Y_o = A_0 + A_1 \ X_1 + A_2 \ X_2 + \ldots + A_n \ X_n$$

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The normal equations had the appearance:

$$\epsilon Y = NA_0 + A_1 \epsilon X_1 + A_2 \epsilon X_2$$
$$\epsilon X_1 Y = A_0 \epsilon X_1 + A_1 \epsilon X_1^2 + A_2 \epsilon X_1 X_2$$
$$\epsilon X_2 Y = A_0 \epsilon X_2 + A_1 \epsilon X_1 X_2 + A_2 \epsilon X_2^2$$

since:

$\epsilon X_j = 0$ and $\epsilon X_j X_k = 0$ the normal equations were
$$\epsilon Y = NA_0$$
$$\epsilon X_1 Y = A_1 \epsilon X_1^2$$
$$\epsilon X_2 Y = A_2 \epsilon X_2^2$$

thus:

$$A_0 = \frac{\epsilon Y}{N} \ , \ A_1 = \frac{\epsilon X_1 Y}{\epsilon X_1^2} \ , \ A_2 = \frac{\epsilon X_2 Y}{\epsilon X_2^2}$$

where

$$\epsilon X_i Y = C_m$$

thus

$$\frac{\epsilon X_i Y}{\epsilon X_i^2}$$

was the same as the sum of squares of a contrast excepting the numerator was not squared.

CONCEPTUAL ANALYSIS OF VARIANCE TABLE FOR TASTE CHARACTERISTICS OF GROUND BEEF

| Source of error | Sum of squares (S.S.) | Degrees of freedom | Mean square (M.S.) | F |
|---|---|---|---|---|
| Block A i | $\dfrac{\epsilon T^2 i \ldots}{bcdn} - C^*$ | $(A-1)$ | A. S. S./A$-$1 | A. M. S./error M. S. |
| Block Bj | $\dfrac{\epsilon T^2 . j \ldots}{acdn} - C$ | $(B-1)$ | B. S. S./B$-$1 | B. M. S./error M. S. |
| Fat level $c_k$ | $\dfrac{\epsilon T^2 .. k ..}{abdn} - C$ | $(C-1)$ | F. S. S./C$-$1 | C. M. S./error M. S. |
| Soya level $D_e$ | $\dfrac{\epsilon T^2 \ldots e .}{abcn} - C$ | $(D-1)$ | S. S. S./D$-$1 | D. M. S./error M. S. |
| Fat$_k$ by soya$_e$ | $\epsilon T^2 .. K E. - S.S._D + \dfrac{T^2 \ldots}{abcdn}$ | $(C-1)(D-1)$ | F. S. S. S./$(C-1)(D-1)$ | C by D M. S./error M. S. |
| Error term | residual | residual | residual S.S./residual d.f. | |
| TOTAL | $\epsilon X^2 ijken - \dfrac{T^2 \ldots}{abcdn}$ | $(a b c d n - 1)$ | | |

$^* C = \dfrac{T^2 \ldots}{abcdn}$