SEQUENTIAL ANALYSIS FOR TESTING QUALITY STANDARD OF FISH HAM AND SAUSAGE

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INTRODUCTION

Fish sausages are finely ground fish flesh, either of a single species or mixed, homogenised with starch, sugar, fat, spices and preservatives, generally filled in cylindrical synthetic or natural casings and pasteurised. Similar products containing small pieces of quality fish and lard are termed "fish ham". They are highly relished products in Japan, annual consumption exceeding 2 lakh tonnes. Preliminary studies in our college have shown that they can catch a lucrative market in our country. However, being a pasteurised product which is often consumed as such without any further cooking, strict quality control measures have to be enforced so as to avoid food poisoning hazards. Besides physical characteristics like absence of damages, pin-holes, curliness and air pockets as well as jelly strength, texture and flavour, chemical characteristics like pH and acid values, moisture, carbohydrate and fat contents and volatile bases have to be assessed. A very important test that has to be carried out along with the above, before passing a lot for free distribution is the bacteriological examination to avoid the presence of pathogenic organisms.

SINGLE SAMPLING V/S SEQUENTIAL SAMPLING

In accepting or rejecting any lot of finished product presented for inspection, usually a single sampling procedure is followed where a random sample of prescribed size from the lot is taken and analysed. The lot is accepted if the random sample conforms to the quality specification laid down by the plan. However, there is another method of sampling known as sequential sampling that can be adopted in accepting or rejecting lots presented for inspection. It differs from the single sampling procedure in that the sample size is not laid down by the plan. Samples continue to be drawn depending on the cumulative result of the samples drawn earlier and comes to a stop when the number of defectives exceeds a particular limit or falls below another limit. As long as the number of defectives lies between these two limits, the sampling procedure has to be continued. The advantage of sequential sampling procedure is that for given producer's and consumer's risks, it usually ends with a smaller sample than under the single sample procedure. The method of adopting this is described here with respect to lots of fish ham and sausage when presented for inspection.

SEQUENTIAL SAMPLING

In the sequential sampling procedure, observations are taken one at a time successively and after drawing of the sample, one of the following three decisions is arrived at: 1) accept the lot, 2) reject the lot, 3) make one additional observation and continue

the procedure. To determine which of these three actions is to be taken, it is necessary to specify the null hypothesis (H_o), alternative hypothesis (H_1), producer's risk (α, type I error), consumer's risk (β, type II error), fraction defective at α (P_o) and fraction defective at β (P_1) for a particular sampling plan.

The usual procedure of lot acceptance sampling by physical attributes alone for fish ham and sausage is as follows: The finished product is accepted if it possesses the following physical attributes: Colouring is moderate and granules of pigment in the connective meat are not conspicuous, agreeable smell is present, taste is good, spices are well matched, elasticity is moderate and no free oil and juice and air spaces are present in the product. Failure of the product to comply with one or more of the above requirements classifies the sample as 'defective'. For adopting the sequential sampling plan, we define the following terms:

$H_o : p = p_o$ at α and $q_o = 1 - p_o$, where α is the probability of rejecting an acceptable lot. $H_1 : p = p_1$ at β and $q_1 = 1 - p_1$, where β is the probability of accepting a bad lot. If d_m is the number of defectives present in a sample of size m of the product, we accept H_o if $d_m \leq$ the acceptance number (a_m) and terminate the procedure. We reject H_o if $d_m \geq$ the rejection number (r_m) and terminate the procedure. If the number of defectives falls between the acceptance and rejection numbers, ie, if $a_m < d_m < r_m$, we continue the procedure by drawing one more sample from the lot. Here,

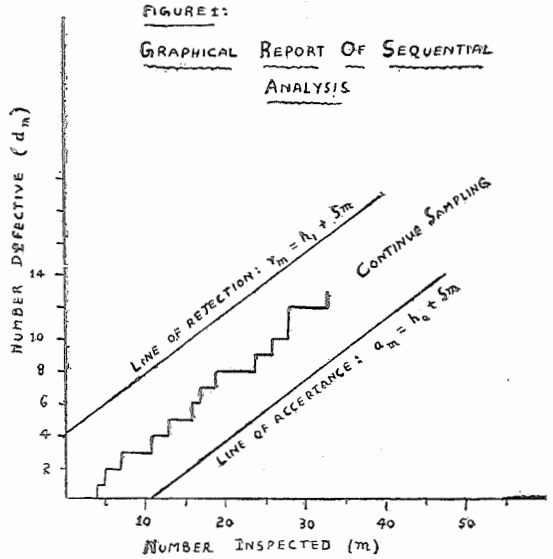
$$a_m = h_o + Sm \quad \ldots\ldots (1)$$

$$r_m = h_1 + Sm \quad \ldots\ldots (2)$$

where $h_o = \dfrac{\log \frac{\beta}{1-\alpha}}{\log \frac{p_1}{p_o} + \log \frac{q_o}{q_1}}$ $\qquad$ $h_1 = \dfrac{\log \frac{1-\beta}{\alpha}}{\log \frac{p_1}{p_o} + \log \frac{q_o}{q_1}}$

and $S = \dfrac{\log \frac{q_o}{q_1}}{\log \frac{p_1}{p_o} + \log \frac{q_o}{q_1}}$

FIGURE 1:
GRAPHICAL REPORT OF SEQUENTIAL ANALYSIS



Equations (1) and (2) are known as the 'Acceptance line' and 'Rejection line' respectively. The above two straight lines are plotted on a chart by taking the sample size m on the X - axis and the defectives d_m on the Y - axis (Fig.1). The result of each successive sample can be recorded one by one by drawing a line one unit to the right if the item is good and a line one unit up if the item is defective. If this graph touches the line of rejection, the sampling procedure has to be stopped at this point and the lot is rejected. The lot is acce-

pted when the graph touches the line of acceptance. The following is an illustration for the above method.

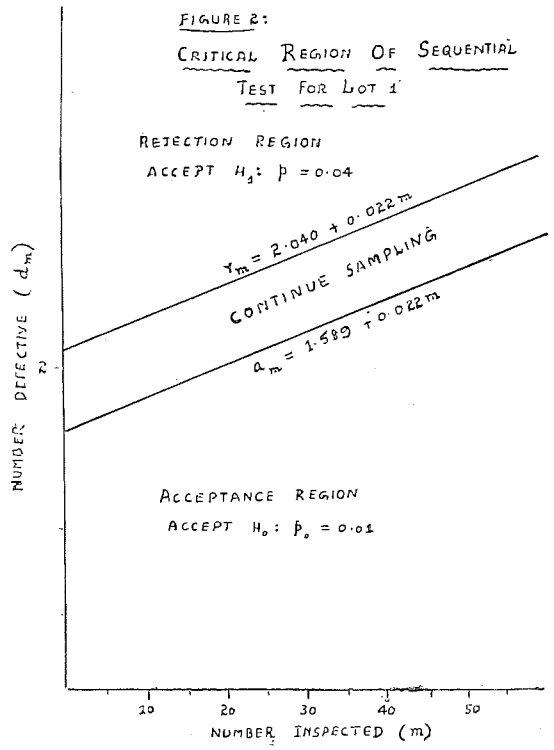
ILLUSTRATION

Suppose we wish to reject the lot of fish ham or sausage product 5% of the time if the proportion of the defective part is 0.01 and accept the lot only at 10% of the time if the proportion of defectives is 0.04; chalk out the sequential analysis for lot 1.

Lot no.	Quantity	Size of sample (not fixed)	Number of defectives
I	4-500	5	3
II	501-5000	6	5

For lot I, given $\alpha = 0.05$ and $\beta = 0.15$, $p_o = 0.01$, hence $q_o = 0.99$ and $p_1 = 0.04$ hence $q_1 = 0.96$, so that, $h_o = 1.589$, $h_1 = 2.04$ and $S = 0.022$. Substituting the above values, the two lines of rejection and acceptance are $a_m = 1.589 + 0.022$ m and $r_m = 2.040 + 0.022$m.

The following table is made use of to represent the above straight lines to form a test chart.



TABULAR ARRANGEMENT FOR SEQUENTIAL SAMPLING OF FISH HAM AND SAUSAGE

m	r_m	a_m
10	2.260	1.809
20	2.480	2.029
30	2.700	2.249
40	2.920	2.469
50	3.140	2.689

The pattern of critical region is shown in figure 2. The testing procedure is continued until the graph touches the rejection or acceptance line.

CONCLUSION

If the products are mass produced, single (random) sampling is most suitable. But when the production is on small scale, lot by lot acceptance by sequential analysis is the most convenient. This plan is economical in the sense it avoids excessive sampling losses; and is superior to any other sampling method now available since it gives the largest number of correct decisions with the smallest amount of information.

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