EVALUATING BEEF CATTLE PRODUCTION ON PASTURE USING ANNUAL EQUIVALENT CASH FLOWS

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INTRODUCTION

It is an indisputable fact that the per capita consumption of protein in Nigeria is low when compared with the UN/FAO estimated minimum considered consistent with a balanced diet. What is more disturbing is the fact that less than one fourth of the per caput consumption come from animal sources (Olayide, et al., 1972). The urgent need therefore to develop programmes and measures to provide adequate animal protein to meet the present and projected needs of the Nigerian population cannot be over-emphasised.

Specific livestock projects exists in the current Third National Development Plan designed to increase the supply of animal protein (Federal Republic of Nigeria: Third National Development Plan, 1975) (see Table 1). Similarly, private initiative in the livestock sub-sector (particularly in the areas of poultry and piggery production) could also serve to reduce the animal protein gap. It is however pertinent to point out that the size of public investment in the livestock sub-sector is far from being adequate in solving the animal protein problem in Nigeria.

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Table 1. Public Sector Capital Programmes for the Livestock Sub-Sector in the Third National Development Plan 1975-1980.

Programme	Expenditure (₦'million)	Percentage Allocation (%)
1. Beef Production*	114.446	34.3
2. Grazing Reserves and Pasture Development	67.4	20.2
3. Livestock Research and Veterinary Services	38.8	11.8
4. Dairy Production	34.4	10.2
5. Poultry	28.5	8.5
6. Piggery	17.2	5.1
7. Livestock Marketing	13.0	3.9
8. Animal Feeds	11.2	3.3
9. Sheep and Goats	4.7	1.4
10. Extension Service	4.4	1.3
Total	334.046	100.0

* A prominent feature of the beef production programme is the establishment of cattle ranches. A total of 44 cattle ranches is to be established during the Plan period.

Source: Federal Republic of Nigeria: Third National Development Plan Vol. 2 pp. 78-119.

Economics of Beef Cattle Production on Pasture.

The aim of this paper is to apply an analytical technique - the Annual Equivalent Cash Flow (AECF) - to a cattle feeding problem and to show the general effects of using the annual equivalent cash flows to evaluate various production alternatives.

The plan of the paper is as follows: In Section II, the functional relationship between stocking rate and the length of the production process in cattle ranching is reviewed. This is followed by a brief presentation of the Annual Equivalent Cash Flow (AECF) technique in Section III. An empirical example is given in Section IV; the results are discussed in Section V while Section VI contains the concluding statements.

II. CATTLE RANCHING: STOCKING RATES AND LENGTH OF PRODUCTION PROCESS.

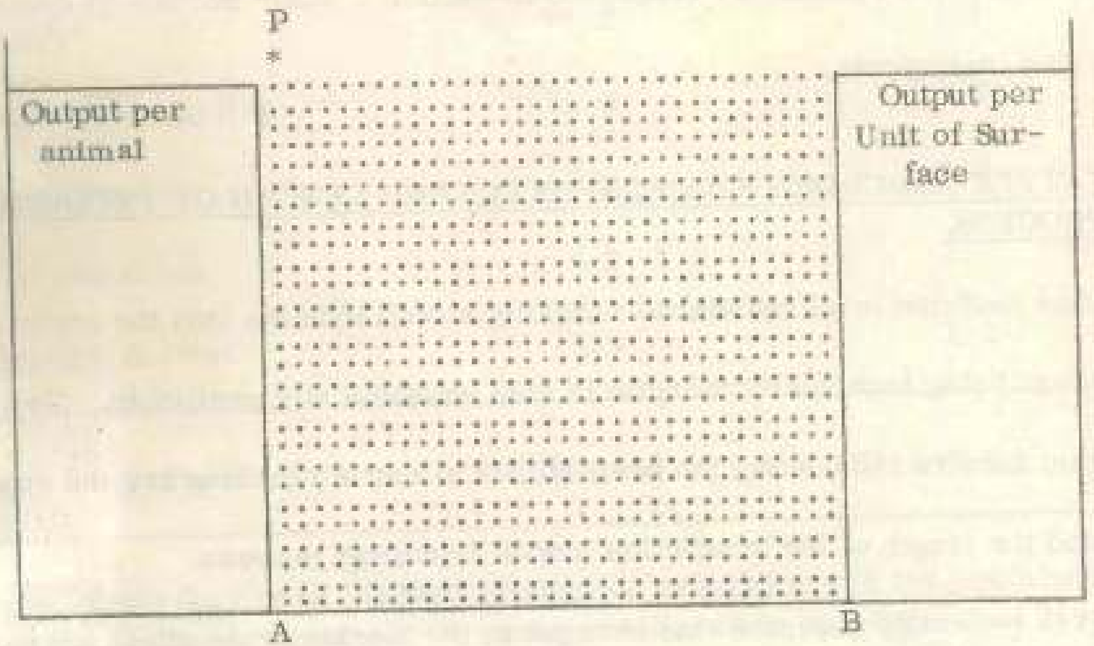
Any decision to go into cattle ranching should indicate that the production apart from being technically feasible is also economically profitable. Two very important factors influencing the profitability of cattle ranching are the stocking rates and the length of the production (cattle fattening) process.

It is generally accepted that changes in the stocking rate affect the amount of body weight produced by beef cattle per unit of surface. Studies exist (Conway, 1970; Gray, 1968; Mott, 1960 and Raymond, 1968) to show that as the stocking rate increases, the total output per unit of surface increases up to a maximum point and after that, decreases very rapidly. At the same time, the output per animal is almost constant during the first stages, decreasing later, before the output per unit of surface reaches a maximum, (see Figure 1.)

From figure 1, it will be seen, that an increase in stocking rate produces at the same time (shaded region):-

1) An increase in output per unit of surface; and
2) A decrease in output per animal (the daily gain per animal diminishes).

Figure 1. The relationship between output per animal and output per unit of surface with increasing stocking rate.



Source: W. F. Raymond, "Grassland Research and Practice", Journal of the Royal Agricultural Society of England, 29 (1968), 94.

costs, revenues and profits has to be used. Such a technique is the annual equivalent cash flow.

III. ANNUAL EQUIVALENT CASH FLOWS.

Since variation in the time that the animal spends on the pasture is a cause of the changes in profits, the annual equivalent cash flow method is an appropriate method for handling the cattle feeding problem. 1/

The implicit assumption is that for a given amount of land the producer will be able to continue with the same method of production, time and time again, until a total common terminal date of production is achieved. It is a comparison between cycles of production. The two basic steps to follow under this approach are:

1. Determining the net present value per unit of surface of land (present value of inflows minus present value of outflows) of each production alternative over the period that each fattening process lasts.
2. Converting the net present value per unit of surface of land of each production alternative into net annual equivalent cash flow. This represents the amount of profit produced by each production alternative per unit of surface of land per unit of time (year).

The decision criterion in this case, when the inflows (revenues) as well as the outflows (costs) are affected by time, is to select the production alternative which provides the highest net annual equivalent cash flow per unit of surface of land

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1/ For details about the Annual Equivalent Cash Flow Technique, see (Aplin and Casler, pp. 67-74).

Economics of Beef Cattle Production on Pasture.

(i. e. profits per unit of surface of land per unit of time (year). The set of equations needed to determine the present value of the inflows and outflows could be stated as follows:

$$A_i = C_i/R^{ti} \qquad i = (1, 2, \ldots m) \qquad (1)$$

where

A_i is the present value of the flow C_i

C_i is the flow to be paid or received in the future.

R is equal to $(1 + r)$ when the interest is compounded once a year and r is the nominal interest rate; or equal to $(1 + r/q)^q$ when the interest is compounded more than once a year, r is the nominal interest rate and q is the number of times the interest is compounded in one year.

t_i is the period of time between the present and the moment in which C_i is received or paid in the future expressed in years.

m is the number of flows for each production process.

This equation (1) is used for flows to be paid or received once in each production process or for flows which are not received or paid at equal intervals of time (that is, outflow of buying the calf, inflow of selling the steer).

$$B_j = D_j(1 - R^{-T}) / (R^1/P_{j-1}) \qquad j = (1, 2, \ldots\ldots n) \qquad (2)$$

where B_j is the present value of the flows D_j.

D_j is the flow to be paid or received at the end of equal intervals of time in the future as long as the production process continues.

T is the total amount of time that the production process lasts expressed in years.

P_j is the number of periodic flows to be considered in each production process.

R is the same as in equation (1).

This equation (2) is used for flows to be paid or received periodically (at the end of equal intervals of time) during all the production process (e.g. salaries).

The net present value of each production alternative will be:

$$F = S \sum_{i=i}^{m} A_i + \sum_{j=1}^{n} B_j + \sum_{i=k} A_i + \sum_{j=k} B_j \qquad (3)$$

where

F is the net present value of the cash flows of the production alternative. The inflows carry a positive sign and the outflows a negative sign.

S is the stocking rate per unit of surface of land 2/. It multiplies all the flows expressed on a per head basic. This has to be done to obtain the net present value on a unit of surface of land basis.

K is the subscript assigned to flows expressed on a per unit of land basis. In this case, it is not necessary to multiply by the stocking rate.

All other symbols have been explained previously.

2/ The stocking rate is defined as the number of cattle units per hectare.

Economics of Beef Cattle Production on Pasture.

The basic equation to calculate the annual equivalent flow per unit of surface of land is:

$$E = F(R - 1) / (1 - R^{-T}) \qquad (4)$$

where

E = is the annual equivalent cash flow per unit of surface of land.

All other symbols have been explained previously.

The variables in this four-equation model are important, but some are of very special significance. These are the nominal interest rate per year (r), the stocking rate (S) and the length of the production process (T).

The choice of the nominal interest rate per year (r) like in any other investment evaluation has a substantial effect on the final decision.

The functional relationship between stocking rate (S) and the length of the production process (T) can vary substantially from country to country, region to region, and even from ranch to ranch. Pasture composition and conditions, breed of animals, starting and finishing weights, are some of the factors which can affect this relationship. The establishment of this functional relationship for each case is of fundamental importance for any evaluation that is intended. To show the relevance of the model just proposed, an empirical example is presented below. The approach adopted avoids the selection of a specific interest rate as well as the functional relationship between stocking rate and the length of the production process. The example is intended only to show the general effects of using annual equivalent cash flows to evaluate various production alternatives rather than to select the stocking rate which maximizes profits in any specific situation. One hopes that in this way, the misleading effects of any particular choice of interest rate and functional relationship between stocking rate and length of production process will be avoided.

IV. EMPIRICAL EXAMPLE

The data used in the empirical example that follows have been extracted from the National Livestock Meat Authority report on Nigerian Ranch Projects (1978), Adegboye, et al. (1978); Sowunmi, (1978) and Ige, (1977).

Given a certain amount of land and various production process lengths, the ratio between the stocking rates which produce the same annual equivalent cash flows will be found. In this way, it will be possible to show that a given proportion process causes a more than proportionate increase in the values of the stocking rate to achieve the same amount of annual equivalent cash flows.

To apply the equation suggested, the flows have to be classified into two groups:

(1) The flows which are paid or received only once per production alternative or flows which are not paid or received at equal intervals of time during the lengths of the production alternative, and

Economics of Beef Cattle Production on Pasture.

(2) the flows which are paid or received at equal intervals of time during the length of the production alternative.

Included in the first group are the following flows:

C_1 = Steer price (₦225.00/head) 3/

C_2 = Calf price (₦70.00/head) 4/

C_3 = Transportation and marketing expenses (₦16.50/head) 5/

To find the present value of these three flows (A_1, A_2 and A_3) equation (1) must be used.

The second group of flows include the following:

D_1 = non-feed costs. These costs include veterinary care, hired labour, etc. A cost of ₦2.45/head/month is assumed 6/

D_2 = land rent. This value is not needed for the comparisons this example is designed for, as is shown below. But it will be very important when the purpose of the study is to select the optimum stocking rate.

To find the present value of these flows, (B_1 and B_2) equation (2) must be used.

3/ A selling weight of 275 kg. is assumed.

4/ Weaning weight of 85 kg. is assumed.

5/ (See Sowunmi, 1978).

6/ (See Adegboye, et al. 1978).

Additional values needed to do the calculations are:

T = time of duration of the production alternative. Since the purpose of the example is to show the relationship between stocking rates when the time of duration of the production alternatives varies and the same annual equivalent cash flows are obtained, several values will be considered. These values are from one year to three years at intervals of six months.

t_1 = The inflow from selling the steer is assumed to occur at the end of the fattening period, then $t_1 = T$.

t_2 = The outflow of buying the calf is assumed to occur at the beginning of the fattening period. Then $t_2 = 0$.

t_3 = The outflow of expenses for transportation and marketing is assumed to occur at the end of the fattening period. Then $t_3 = T$.

B_1 = The number of times the non-feed costs are paid per year. A monthly payment is assumed thereby making $B_1 = 12$.

B_2 = The number of times the rent value of the land is paid per year. This is assumed to be 1, $R = (1 + r)$.

where,

r = is the nominal interest rate. To show the consequences of using different interest rates, the results will be presented for two of them, six and ten percent per year [7]. It is assumed that the interest rate is compounded annually.

Having defined all the variables, the annual equivalent cash flows for any two stocking rates S and S' and length of the production alternative T and T' will be

$$E = S(A_1 - A_2 - A_3 - B_1) - B_2 \quad R - 1 \;/\; 1 - R^T \tag{5}$$

and

$$E' = S'(A'_1 - A'_2 - A'_3 - B'_1) - B'_2 \quad R-1 \;/\; 1 - R^T \tag{6}$$

since

$$B_2 = \frac{D_2 \quad 1 - R^{-T}}{R - 1} \tag{7}$$

and

$$B'_2 = \frac{D_2\,(1 - R^{-T'})}{(R - 1)} \tag{8}$$

It is possible to replace (7) and (5) and (8) in (6) and simplify to obtain:

$$E = S \quad \frac{(A1 - A2 - A3 - B1)\,(R - 1)}{(1-R^{-T})} \quad D_2 \tag{9}$$

and

$$E' = S' \quad \frac{A'_1 - A'_2 - A'_3 - B'_1)(R - 1)}{(1 - R^{-T})} - D_2 \tag{10}$$

Equhting both annual equivalent cash flows and simplifying, the following equation is obtained:

$$\frac{S(A1 - A2 - A3 - B1)}{(1 - R^{-T})} = \frac{S'(A'1 - A'_2 - A'_3 - B'_1)}{(1 - R^{-T'})} \tag{11}$$

Now, it is possible to find the ratio RTT' between the two stocking rates as follows:

$$R_{TT'} = S/S' = \frac{(A'_1 - A'_2 - A'_3 - B'_1)(1 - R^{-T})}{(A_1 - A_2 - A_3 - B_1)(1 - R^{-T'})} \tag{12}$$

The ratio $R_{TT'}$ will represent the relationship which must exist between two stocking rates to have equal annual equivalent cash flows, when the time spent by the animal under the production alternative with stocking rate S is T and when the time spent by the animal under the production alternative with stocking rate S' is T'.

V. RESULTS

The results are presented in Tables 2 and 3 in the following way: the number which appears in the intersection of a column with a row means the ratio that must exist between the stocking rate of the production alternative lasting the amount of time headed by the column as numerator, and the stocking rate of the production alternative lasting the amount of time headed by the row as denominator, to obtain equal annual equivalent cash flows.

Examples will illustrate the way in which the tables work.

(1) At the intersection of column 2 years with row 1 year in Table 2, appears the value 2.97. This means that 2.97 times the stocking rate existing for the production alternative lasting 1 year is needed to obtain the same annual equivalent cash flow when the length of time of the production alternative is increased to 2 years.

(2) In the same table, at the intersection of column 2 years with row 3 years appears the value 0.41. This means that with only 0.41 of the stocking rate existing fro the production alternative lasting 3 years, it is possible

to have the same annual equivalent cash flows if the time of the production alternative is reduced from 3 years to 2 years. In both cases, the nominal interest rate considered was 6 percent.

Table 2. Necessary stocking rates ratio to have equal equivalent cash flows when the length of the fattening process changes for a nominal interest rate of 6 percent compounded annually.

Length of the fattening process (Years).

T' \ T	1.0	1.5	2.0	2.5	3.0
1.0	1.00	1.78	2.97	4.88	8.68
1.5	0.56	1.00	1.67	2.74	4.88
2.0	0.34	0.60	1.00	1.64	2.46
2.5	0.21	0.36	0.61	1.00	1.78
3.0	0.12	0.20	0.41	0.56	1.00

If the nominal interest rate considered is 10 percent, the values to be obtained for the two previous cases are 3.27 and 0.25, (see Table 3). This means that for higher nominal interest rates,

(i) greater increase in stocking rates are needed to obtain the same annual equivalent cash flows when the length of the production process is extended; and

(ii) greater reduction in stocking rates are needed to obtain the same annual equivalent cash flows when the length of the production process is decreased.

Table 3. Necessary stocking rate ratio to have equal equivalent cash flows when the length of the fattening process changes for a nominal interest rate of 6 percent compounded annually.

Length of the Fattening Process (Years)

T' \ T	1.0	1.5	2.0	2.5	3.0
1.0	1.00	1.84	3.27	5.88	12.5
1.5	0.54	1.00	1.78	3.19	7.25
2.0	0.31	0.56	1.00	1.79	4.05
2.5	0.17	0.31	0.55	1.00	2.25
3.0	0.08	0.14	0.25	0.44	1.00

The results in Tables 2 and 3 show that as the time of the production alternatives increases, the stocking rate needed to obtain the same annual equivalent cash flow also has to be increased. The increase in stocking rates has to be proportionally greater than the increase in length of time.

VI. CONCLUSIONS.

Stocking rates and the length of the production (fattening) process are important factors affecting the profitability of beef cattle prodution on pastures.

It has been shown by way of an example that as the length of time of the production alternatives is increased in a given proportion, the stocking rate has to be increased more than such a proportion to maintain the same level of profits per unit of surface of land per unit of time.

This means that changes in stocking rates which result in changes in the length of time of the fattening process have to be carefully evaluated because the reduction in profit caused by the increase in the length of time of the production process can offset the increase in profit caused by the greater production obtained as a result of higher stocking rates.

The annual equivalent cash flow technique is suitable for this kind of analysis and its use is recommended when the goal is to maximize profit per unit of surface of land per unit of time.

REFERENCES

ADEGBOYE, R.O., et al. A Socio-Economic Study of Fulani Nomads in Kwara State. Department of Agricultural Economics, University of Ibadan. August, 1978.

APLIN, R.D. and CASLER, G.L. Capital Investment Analysis Grid. Inc. Columbus Ohio, 1973.

CONWAY, A. "Grazing Management for Beef Production". Journal of the British Grassland Society, 25 (March 1970), pp. 85-91.

Federal Republic of Nigeria: Third National Development Plan, 1975 - 1980. Vols. I & II. Federal Ministry of Economic Development, Lagos, 1975.

GRAY, J.M. Ranch Economics (Ames: The Iowa State Univ. Press, 1968).

IGE, U.O. "Comparative Cost Analysis of Beef Cattle Production in Government Farms". Final year Undergraduate Student Project, Depar ment of Agricultural Economics, University of Ibadan, May 1977.

MOTT, G.O. "Grazing Pressure and the Measurement of Pasture Production". Proceedings of the Eighth International Grassland Congress (1960), pp. 606-611.

Nigerian Livestock Meat Authority: The Nigerian Ranch Projects: Analysis, Appraisal and Summary of the Ranch Project Proposals, Kaduna, April 1978.

OLAYIDE, S.O. et. al. A Quantitative Analysis of Food Requirements, Supplies and Demands in Nigeria, 1968-1985. Federal Department of Agriculture, Lagos, Nigeria, 1972. (pp. 9-50).

RAYMOND, W.F. "Grassland Researdh and Practice", Journal of the Royal Agricultural Society of England, 129 (1968), pp. 85-109.

SOWUNMI, A.A. "Beef Marketing in Oyo State". Final Year Student Project, Department of Agricultural Economics, University of Ibadan, May 1978.

MICROBIAL PROTEINS IN DIETS FOR RATS

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SUMMARY

Two experiments involving 130 rats were conducted to evaluate the nutritive value of three microbial proteins for rats. In one of the experiments, diets containing 0, 20 and 30% microbial protein were offered for 21 days. Inclusion of up to 20% microbial protein did not significantly affect liveweight gain but a comparatively poor feed conversion efficiency was manifested at levels above 10% inclusion of the protein concentrate in the diet. In a second experiment, the microbial protein was incorporated at a level of 30% as the sole source of protein to measure the digestibility of nitrogen and RNA. The apparent digestibility of nitrogen was 80 - 89% and that of RNA was 76 - 83%.

INTRODUCTION

There is need to increase food production particularly proteins to satisfy the needs of the increasing human population. Traditional agricultural practice alone cannot meet this demand.

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In recent years, efforts have been intensified to increase the production of protein from microorganisms which can utilise organic waste. These microorganisms include bacteria, yeasts, filamentous fungi and algae (Ratledge, 1968; Calloway and Kumar, 1969; Clement, 1972). Their production involves fermentation procedure with the exception of algae which are produced photosynthetically. Substrates such as carbohydrates (cellulose, starch), petroleum waste or by-products (gas oil, n - paraffins, methane,methanol and ethanol) are being used as the carbon source - Ghose, 1969; Klug and Markovetz, 1971; Spicer, 1971; Bewersdorff and Dostalek, 1971. Apart from algae, these microorganisms derive energy from the oxidation of organic compounds. Ammonia and nitrates serve as the source of nitrogen and the medium is supplemented with minerals.

Since these products are intended for use as protein and energy sources for animals and humans in place of conventional protein supplements, knowledge of their nutritive qualities is desirable. Some nutrition experiments using chicks and pigs have been reported by Van Weerden, Shacklady and Van der Waal (1970); Lewis, Boorman and Moorgan (1971) and Shannon and McNab (1972). The objective of this study was to investigate the effect of including graded levels of three microbial proteins in the diets of rats on their growth rate and feed efficiency. The digestibility of the nitrogen and ribonucleic acid (RNA) was also determined. Two of the microbial proteins are yeasts, one was grown on n-paraffins and used as such (Yeast 1), the other was grown on crude gas oil and therefore was solvent extracted to remove residual crude oil after harvesting (Yeast 2). The third microbial protein was a filamentous fungus grown on carbohydrate waste (Filamentous fungus).

MATERIALS AND METHODS

Diets.

The effect of different dietary levels of inclusion of the microbial protein on growth rate and feed efficiency was determined by replacing 10, 20 and 30% of white fishmeal present in a basal diet (Table 1) with each of the microbial protein. Casein was added in place of glucose to raise the protein level of diets containing the microbial samples, where necessary, to the same level as that of the basal diet. The fishmeal used in this diet contains 69.11% crude protein on a dry matter basis.

A ration (Table 2) in which each of the test samples was included at a level of 30% as the sole source of protein was fed to measure the digestibility of the nitrogen and RNA. Feed and water were offered *ad libitum*.

Animals.

Weanling male Wistar rats, average weight 48.7g, were randomly allocated at the rate of 10 rats per treatment. Rats were weighed at the start of the experimen

Table 1. Composition of diets used for the growth experiment. Values expressed as percent of diet.

	1	2	3	4	5	6	7	8	9	10
Glucose	20.0	19.1	18.2	17.3	20.0	20.0	20.0	18.5	17.0	15.4
Maize starch	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
Dextrinized starch	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4
Maize oil	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Cellulose powder	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
White fishmeal	32.0	22.0	12.0	2.0	22.0	12.0	2.0	22.0	12.0	2.0
Casein	-	0.9	1.8	2.7	-	-	-	1.5	3.0	4.6
Mineral mixture [a]	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
B-vitamin supplement [b]	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Fat soluble vitamin [c]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Yeast 1	-	10.0	20.0	30.0	-	-	-	-	-	-
Yeast 2	-	-	-	-	10.0	20.0	30.0	-	-	-
Filamentous fungus	-	-	-	-	-	-	-	10.0	20.0	30.0

a. Mineral mixture supplied the following g/kg of diet: KH_2PO_4, 15.54; $MgSO_4$, 2.29; $CaCO_3$, 15.24; $FeSO_4 \cdot 7H_2O$, 1.08; KI, 0.03; $MnSO_4 \cdot 4H_2O$, 0.230; $ZnCO_3$, 0.020; $CuSO_4 \cdot 5H_2O$, 0.019; $CoCl_2$, 0.001; NaCl, 15.55.

b. B-vitamin supplement supplied the following g/kg of diet; thiamine, 0.003; riboflavin, 0.01; pyridoxine, 0.004; calcium panthothenate, 0.06; nicotinic acid, 2.0; inositol, 4.0; p-aminobenzoic acid, 6.0; biotin, 0.002; folic acid, 0.05 and choline, 12.0.

c. Fat soluble vitamin mixture supplied the following g/kg of diet: retinol, 10,000 IU; ergocalciferol, 500 IU; menaothone, 2 mg, and mixed tocopherols, 2mg.