

## SOYBEAN PEPTIDE AS ADDITIVE ON YELLOW FEATHER BROILER CHICKS: NUTRITIONAL AND BIOCHEMICAL PROFILES

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### ABSTRACT

*The peptide under investigation was biotechnologically manufactured from non-GM soybean and sold on the Chinese market by China CF Duqing (Heze) Biotech Co. Ltd, Shandong Province, China. For the purpose of this study, the peptide was designated marketed soybean peptide (MSBP). In order to show its efficacy as growth promotant, it was used as additive in experimental diets at the inclusion levels of 0.1%, 0.2%, 0.3%, 0.4% and 0.5%. The control diet was mainly basal broiler starter feed. The duration of the study was 3 weeks. The total number of day-old-chicks used was 1,620 and the experimental design was such that it had 6 treatments of 6 replicates with 45 chicks per replicate. Six chicks were randomly selected from each replicate at the end of the study and blood samples as well as some organs were taken for biochemical assays. There were significant improvement in average daily weight gain (ADWG) and feed conversion efficiency (FCE) in chicks fed diets containing 0.1% and 0.4% MSBP compared to those fed the other diets, including the control [ $P < 0.05$ ]. The use of MSBP at the stated levels did not influence the total lipid levels in the heart and liver, serum triglyceride and HDL in all the chicks fed those diets relative to the control ( $P > 0.05$ ). The study further revealed that increasing the concentration of MSBP in the diets did not cause a corresponding increase or decrease in the serum levels of AST, ACP, total protein, albumin and globulin. Also, MSBP, at all the levels of inclusion studied, resulted in significant serum cholesterol reduction compared to the control treatment ( $P < 0.05$ ) i.e. the cholesterol lowering ability of MSBP was established.*

### INTRODUCTION

Some of the principal pre-occupations of the world today are the threat posed by the precarious food security, poverty and hunger with their attendant disease conditions. This was re-echoed at the 2007 World Food Day celebration organised by FAO of the United Nations Organisation, where the theme for the celebration was "World Food Security: The challenges

of climate change and bio-energy". According to figures released by FAO, 75 million more people slid below the hunger threshold in 2007, bringing the estimated number of hungry people worldwide to 923 million ([www.fao.org/newsroom/en/news/2008/1000945/index.html](http://www.fao.org/newsroom/en/news/2008/1000945/index.html)). Furthermore, FAO estimation in 2007 depicted that another 40 million people were pushed into hunger, primarily due to the

high global food prices and thus, brought the overall number of undernourished people in the world to 963 million ([www.fao.org/news/story/en/item/8836/icode](http://www.fao.org/news/story/en/item/8836/icode)). A variety of measures and complementary efforts are being considered and implemented, all with the view to circumventing as well as containing this global menace. One of the new laudable measures with promising impact has been the introduction of peptides in farm animal feeding regimen. For instance, the dipeptide, carnosine ( $\beta$ -alanyl-L-histidine) is reported to enhance the stability of meat in storage (Djenane *et al.*, 2004), contributes to nutritional quality, possesses hypoglycaemic, hypotensive and anti-aging effects (Tomonaga *et al.*, 2006; Nijima *et al.*, 2002) as well as improves the productive performance of yellow feather broilers (Jianfu, 2004).

Currently on the Chinese market, are a host of products, particularly peptides that are being advertised, sold and used for a variety of nutritional purposes, such as growth promotion, performance enhancement, etc. There is, however, scanty information on the suitability and efficacy or otherwise of these peptides in promoting growth in farm animals, especially broiler chicks. This study, therefore, set out to investigate the use of one of these peptides on the Chinese market, referred to as MSBP as additive in promoting the growth of broiler chicks. Furthermore, the study sought to determine the impact of this peptide on the nutritional and biochemical status of the birds.

## MATERIALS AND METHODS

### Materials and chemicals

The non-GM soybean peptide which was the subject of this study was purchased from Guangzhou Cinjep Biotechnology Co. Ltd, Guangzhou, China, a subsidiary of China CF Duqing (Heze) Biotech. Co. Ltd, Shandong province, China, the parent company that biotechnologically manufactured it. For the purpose of this work, the soybean peptide was designated MSBP (marketed soybean peptide). It was mechanically milled to consistent particle size of less than 0.7 mm (using Christy hammer mill, Christy and Norris Limited, England),

packaged and stored at  $-20^{\circ}\text{C}$  till required for use. All the male yellow feather broiler chicks used in the present study were obtained from the hatchery outfit of Wen's Foodstuff Group Co. Ltd, Xinxing, Guangdong Province, China. All the feed ingredients used in formulating the various test diets were obtained from the Wen's Foodstuff Group Co. Ltd while the feeding trials were conducted on the company's poultry experimental station. The reagent kits for assaying the biochemical indices were obtained from DiaSys, Germany, through its subsidiary company DiaSys Diagnostic Tech. Co. Ltd, Shanghai, China.

### Feeding trial

The feed formulation was designed such that there were 6 treatments of 6 replicates, comprising 45 birds per replicate i.e.  $6 \times 6 \times 45$ . The chicks were randomly assigned to the treatments while water and feed were given *ad libitum*. The total number of day-old-chicks used was 1,620 and they were fed for 3 consecutive weeks. The experimental birds received humane care as outlined in the Guide for the Care and Use of Experimental Animals (Research Policy, Chinese Academy of Agricultural Science). During the feeding period, the following parameters; feed consumption, weekly weight measurement, physical and behavioural changes, were monitored and records kept. The chicks were closely monitored for signs of discomfort and mortality. For the determination of feed intake and feed conversion efficiency (FCE), records of both dead birds as well as their weights were kept.

FCE was calculated as feed consumption per day per chick (g) divided by body weight gain/loss (g)

The following nutrient parameters in the formulated feed were analyzed: crude protein [CP] (Tecator Application Notes, 1983), mineral ash, ether extract, moisture, crude fibre, available carbohydrate, Ca, P (AOAC, 1984) and amino acids namely lysine, methionine and cysteine (AccQ-Taq method).

**Sample Collection and analysis**

At the end of the feeding period and after overnight feed deprivation, thirty-six chicks (6 chicks from each replicate) were randomly selected, sacrificed and blood drawn for biochemical assays. The blood samples were made to clot before being centrifuged at the set conditions of 4,000 rpm, 4 °C for fifteen minutes and the resultant sera used for the assays. The heart and liver of the birds were excised, blotted dry of fluid and debris, weighed and preserved in 10% formalin for the total lipid determination. 200 – 500 µl of serum was pipetted and assayed for the biochemical indices (total protein, albumin, AST, ALT, ALP, total cholesterol and HDL) by the direct injection into Synchron CX5 analyzer (Synchron CX5 Clinical System Delta, Beckman Coulter, USA). Total lipid concentration in the excised organs was determined by the method of Folch *et al.* (1957) while the globulin level was by simple calculation. Serum acid phosphatase (ACP) was determined by the method described by Kaplan and Szabo (1983).

The serum LDL was obtained by calculation:  
 $LDL = \text{Total cholesterol} - (\text{HDL-cholesterol} + 1/5 \times \text{serum triglyceride})$

Note: the factor  $1/5 \times \text{triglyceride}$  corrects for average cholesterol concentration in serum VLDL, according to the method described by Kaplan and Szabo (1983).

**Statistical analysis**

The nutritional performances as well as biochemical indices determined in the birds were compared across the treatments using the one-way analysis of variance (ANOVA) procedure. Significant differences between means were then determined using the Duncan's multiple range tests. All statistical tests were conducted at 95% confidence level, using the SAS programme (SAS, 1991).

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**RESULTS AND DISCUSSION****Nutritional Response to MSBP feeding**

The nutritional response of male yellow feather chicks to graded levels of the peptide MSBP, fed as additive is presented in Table 2. At the end of the feeding trial, chicks fed diets containing 0.1% MSBP (treatment A) and 0.4% MSBP (treatment D) made significant improvement in total weight gain, ADWG and FCE ( $P < 0.05$ ). For instance, the ADWG of treatments A and D were 19.30 g/chick/day and 18.89 g/chick/day while those determined for chicks fed treatments B, C, E and F were 18.06 g/chick/day, 18.33 g/chick/day, 18.39 g/chick/day and 18.42 g/chick/day respectively. The improved growth performance of treatments A and D, coupled with the near zero mortality rate confirmed what Cunningham and Acker (2001) had earlier observed. They reported that the wide acceptance of feed additives in swine and poultry rations is attributed to their well-established beneficial influence in improving growth rates, enhancing feed conversion as well as reducing mortality and morbidity caused by clinical and sub-clinical infections. The near zero mortality recorded in the study, irrespective of the different treatments used is suggestive of the fact that MSBP, when used up to 0.5% would safeguard the health status of the birds.

Furthermore, short-chained peptides as well as those produced by way of protein digestion have been reported to be easily and wholly absorbed directly into the bloodstream to aid in signal transmission from one neurone to another, accelerate cell growth, DNA synthesis, speed up growth rate and improve nutritional values, among others (Zambonino Infante *et al.*, 1997; Azumah and Yamauchi, 1987; Lehmann, 1982). The enhanced growth output of chicks fed treatments A and D relative to the others, including the control conflicted the ob-

servation made by Furuse (2002) to the effect that higher growth rate is always associated with higher feed intake. The average daily feed intake (ADFI) pattern showed no significant variations among the chicks, regardless of the treatments ( $P>0.05$ ). On the whole, it could be

adduced that even though all the chicks statistically consumed equal quantities of feed ( $P>0.05$ ), those fed treatments A and D were able to utilise the feed better by gaining comparatively significant higher growth performance ( $P<0.05$ ).

**Table 1: Feeding Trial with MSBP Broiler Starter Diets (0 - 3 Weeks)**

Feed Ingredient	Trial with MBSP (%)					
	0.0	0.10	0.20	0.30	0.40	0.50
Fishmeal	3	3	3	3	3	3
Soybean(44)	32	32	32	32	32	32
Maize	59.7	59.7	59.7	59.7	59.7	59.7
Oil	1	1	1	1	1	1
CaCO <sub>3</sub>	1.5	1.5	1.5	1.5	1.5	1.5
CaHPO <sub>4</sub>	1.4	1.4	1.5	1.5	1.5	1.5
Met	0.11	0.11	0.11	0.11	0.11	0.11
Lys	0.10	0.10	0.10	0.10	0.10	0.10
NaCl	0.30	0.30	0.30	0.30	0.30	0.30
Carrier	0.50	0.40	0.30	0.20	0.10	0.00
MSBP	-	0.10	0.20	0.30	0.40	0.50
Choline Cl	0.15	0.15	0.15	0.15	0.15	0.15
Premix Mineral	0.20	0.20	0.20	0.20	0.20	0.20
Premix Vitamin	0.04	0.04	0.04	0.04	0.04	0.04
Total	100%	100%	100%	100%	100%	100%
	<b>Determined Nutrient Levels (%)</b>					
Nutrient	0%	0.1%	0.2%	0.3%	0.4%	0.5%
Moisture	12.68	11.74	12.91	12.93	11.18	13.22
Crude Protein	20.81	20.58	20.46	20.33	20.08	20.67
Ether Extract	6.77	6.54	6.77	6.43	6.71	7.09
Ash	5.76	5.62	5.71	5.48	5.54	5.88
C. Fibre	4.30	3.84	3.99	3.68	4.39	4.36
Available CHO	49.68	51.68	50.16	51.15	52.10	48.78
GE (Kcal/kg)	3,428	3,478	3,435	3,438	3,490	3,416
Ca	0.023	0.022	0.024	0.021	0.027	0.023
P	0.612	0.608	0.597	0.615	0.647	0.613
Lys	1.167	1.166	1.167	1.167	1.169	1.170
Met	0.450	0.451	0.450	0.450	0.452	0.453
Met + Cys	0.776	0.775	0.777	0.777	0.778	0.777

@ Control (broiler starter feed)

MSBP – Test peptide

®Supplied the following per kg of completed diet: Vitamin A – 12,000 IU;

Vitamin D<sub>3</sub> – 1,500 IU; Vitamin E – 40 IU; Vitamin K<sub>3</sub> – 1.2 mg; thiamine – 1 mg;

riboflavin – 6 mg; calpan – 20 mg; niacin – 30 mg; pyridoxine – 3 mg; Vitamin B12 – 20 µg;

folacin – 1.0 mg; biotin – 0.1 mg; Choline chloride – 500 mg; Se – 0.30 mg; Fe – 120 mg;

Mn – 65 mg; Zn – 100 mg; Cu – 8 mg; I<sub>2</sub> – 0.4 mg

**Organ and serum total lipid profiles**

The influence of MSBP as feed additive on the serum and organ lipid profiles of chicks fed both test and control diets are shown in Tables 3 and 4. There were no significant differences in the total lipid levels in the heart and liver of

the chicks fed the test treatments when compared with that of the control ( $P>0.05$ ). Similar pattern was observed in the serum triglyceride levels. Serum triglyceride concentration should be monitored since a high concentration is reportedly one of the risk factors in the incidence

**Table 2: Nutritional impact of MSBP fed as additive on growth indices**

Sample	Weight at Day 21 (g/chick)	Total Weight after 21 days (kg)	ADWG (g/chick/day)	FCE	ADFI (g/chick/day)	Survival rate (%)
A (0.1 %)	444.17 ± 11.58 <sup>a</sup>	18.21 ± 0.55 <sup>a</sup>	19.30 ± 0.56 <sup>a</sup>	1.705 ± 0.02 <sup>a</sup>	33.00 ± 0.75 <sup>a</sup>	99.63 ± 0.90 <sup>a</sup>
B (0.2 %)	430.00 ± 9.21 <sup>b</sup>	17.48 ± 0.55 <sup>b</sup>	18.06 ± 0.44 <sup>b</sup>	1.758 ± 0.03 <sup>b</sup>	32.63 ± 0.78 <sup>a</sup>	99.63 ± 0.90 <sup>a</sup>
C (0.3%)	425.00 ± 8.34 <sup>b</sup>	17.02 ± 0.49 <sup>b</sup>	18.33 ± 0.40 <sup>b</sup>	1.753 ± 0.04 <sup>b</sup>	32.27 ± 0.55 <sup>a</sup>	98.53 ± 1.34 <sup>a</sup>
D (0.4%)	436.83 ± 11.94 <sup>a</sup>	17.60 ± 0.79 <sup>a</sup>	18.89 ± 0.57 <sup>a</sup>	1.715 ± 0.02 <sup>a</sup>	33.00 ± 0.76 <sup>a</sup>	98.90 ± 1.84 <sup>a</sup>
E (0.5%)	426.17 ± 14.19 <sup>b</sup>	17.19 ± 0.83 <sup>b</sup>	18.39 ± 0.68 <sup>b</sup>	1.763 ± 0.04 <sup>b</sup>	32.45 ± 0.53 <sup>a</sup>	98.9 ± 1.84 <sup>a</sup>
F (0%) (Control)	427.00 ± 6.60 <sup>b</sup>	17.25 ± 0.31 <sup>b</sup>	18.42 ± 0.31 <sup>b</sup>	1.776 ± 0.01 <sup>b</sup>	32.68 ± 0.57 <sup>a</sup>	99.12 ± 1.97 <sup>a</sup>

Means of 6 replicates and superscripts with same letters indicate no significant difference ( $P>0.05$ )

ADWG == Average Daily Weight Gain

FCE == Feed Conversion Efficiency

ADFI == Average Daily Feed Intake

**Table 3: Organ and serum total lipid and triglyceride levels of male broiler chicks**

Sample	Serum TG (mmol/L)	Total Lipid (%)	
		Heart	Liver
A (0.1% MSBP)	0.47 ± 0.02 <sup>a</sup>	0.83 ± 0.08 <sup>a</sup>	5.22 ± 0.27 <sup>a</sup>
B (0.2% MSBP)	0.50 ± 0.08 <sup>a</sup>	0.69 ± 0.27 <sup>a</sup>	3.98 ± 0.27 <sup>a</sup>
C (0.3% MSBP)	0.44 ± 0.55 <sup>a</sup>	0.41 ± 0.38 <sup>a</sup>	2.35 ± 0.12 <sup>a</sup>
D (0.4% MSBP)	0.50 ± 0.04 <sup>a</sup>	0.67 ± 0.06 <sup>a</sup>	2.53 ± 0.21 <sup>a</sup>
E (0.5% MSBP)	0.42 ± 0.01 <sup>a</sup>	0.83 ± 0.06 <sup>a</sup>	2.26 ± 0.21 <sup>a</sup>
F (0% - Control)	0.48 ± 0.19 <sup>a</sup>	1.69 ± 0.16 <sup>a</sup>	2.81 ± 0.39 <sup>a</sup>

Means in a column with different superscript letters are significantly different ( $P<0.05$ ) [ $n=6$ ] TG == Triglyceride

**Table 4: Serum lipid levels of male broiler chicks fed graded MSBP-containing diets**

Sample	T. Chol (mmol/L)	LDL (mmol/L)	HDL (mmol/L)	LDL:HDL ratio	CHD Risk 1	CHD Risk 2
A(0.1% MSBP)	3.91 ± 0.22 <sup>a</sup>	1.57 ± 0.32 <sup>b</sup>	2.25 ± 0.14 <sup>a</sup>	0.71 ± 0.18 <sup>a</sup>	1.74 ± 0.46 <sup>a</sup>	2.50 ± 0.18 <sup>a</sup>
B(0.2% MSBP)	3.71 ± 0.16 <sup>a</sup>	1.25 ± 0.22 <sup>b</sup>	2.35 ± 0.26 <sup>a</sup>	0.55 ± 0.16 <sup>a</sup>	1.57 ± 0.98 <sup>a</sup>	2.97 ± 0.44 <sup>a</sup>
C(0.3% MSBP)	3.52 ± 0.29 <sup>a</sup>	0.83 ± 0.35 <sup>b</sup>	2.61 ± 0.25 <sup>a</sup>	0.33 ± 0.16 <sup>b</sup>	1.35 ± 0.27 <sup>a</sup>	4.24 ± 0.65 <sup>b</sup>
D(0.4% MSBP)	3.80 ± 0.40 <sup>a</sup>	1.37 ± 0.44 <sup>b</sup>	2.33 ± 0.18 <sup>a</sup>	0.59 ± 0.18 <sup>a</sup>	1.63 ± 0.52 <sup>a</sup>	2.61 ± 0.42 <sup>a</sup>
E (0.5% MSBP)	3.39 ± 0.24 <sup>a</sup>	0.91 ± 0.38 <sup>b</sup>	2.40 ± 0.12 <sup>a</sup>	0.38 ± 0.08 <sup>b</sup>	1.41 ± 0.23 <sup>a</sup>	3.73 ± 0.84 <sup>b</sup>
F(Control)	5.11 ± 1.72 <sup>b</sup>	2.69 ± 1.90 <sup>a</sup>	2.32 ± 0.39 <sup>a</sup>	1.23 ± 0.88 <sup>a</sup>	2.20 ± 0.32 <sup>a</sup>	1.90 ± 0.59 <sup>a</sup>

Means in a column with different superscript letters are significantly different ( $P < 0.05$ ) [ $n=6$ ]

T. Chol == Total cholesterol

LDL == Low Density Lipoprotein

HDL == High Density Lipoprotein

CHD == Cardiovascular heart disease

**Table 5: Serum protein and enzyme levels of male broiler chicks fed graded MSBP**

Sample	T. Protein (g/L)	Albumin (g/L)	Globulin (g/L)	ALT (IU/L)	AST (IU/L)	ALP ( $\times 10^4$ IU/L)	ACP (U/100 ml)
A (0.1%)	14.94 ± 0.22 <sup>a</sup>	6.35 ± 0.10 <sup>a</sup>	8.59 ± 5.26 <sup>a</sup>	4.07 ± 0.98 <sup>a</sup>	220.76 ± 20.93 <sup>a</sup>	2.13 ± 0.39 <sup>a</sup>	12.83 ± 1.36 <sup>a</sup>
B (0.2%)	19.28 ± 1.12 <sup>a</sup>	7.05 ± 0.13 <sup>a</sup>	12.23 ± 0.99 <sup>a</sup>	6.14 ± 1.52 <sup>a</sup>	251.16 ± 21.07 <sup>a</sup>	0.72 ± 0.28 <sup>c</sup>	13.94 ± 0.70 <sup>a</sup>
C (0.3%)	18.86 ± 3.35 <sup>a</sup>	7.05 ± 0.48 <sup>a</sup>	11.81 ± 3.06 <sup>a</sup>	3.13 ± 0.98 <sup>b</sup>	214.67 ± 27.18 <sup>a</sup>	0.87 ± 0.59 <sup>c</sup>	12.52 ± 1.78 <sup>a</sup>
D (0.4%)	15.26 ± 2.74 <sup>a</sup>	6.72 ± 0.39 <sup>a</sup>	8.54 ± 2.43 <sup>a</sup>	5.46 ± 2.90 <sup>a</sup>	251.89 ± 12.42 <sup>a</sup>	1.65 ± 0.12 <sup>b</sup>	13.58 ± 3.21 <sup>a</sup>
E (0.5%)	10.02 ± 1.19 <sup>a</sup>	6.40 ± 0.22 <sup>a</sup>	3.62 ± 1.01 <sup>a</sup>	7.14 ± 1.13 <sup>a</sup>	235.98 ± 26.48 <sup>a</sup>	1.69 ± 0.52 <sup>b</sup>	13.10 ± 1.77 <sup>a</sup>
F (Contr.)	23.47 ± 3.27 <sup>a</sup>	6.39 ± 2.04 <sup>a</sup>	17.08 ± 2.49 <sup>a</sup>	5.85 ± 2.98 <sup>a</sup>	241.94 ± 23.97 <sup>a</sup>	0.90 ± 0.10 <sup>c</sup>	11.23 ± 1.14 <sup>a</sup>

Means in a column with same superscript letters are not significantly different ( $P > 0.05$ ) [ $n=6$ ]

ALT == Alanine aminotransferase

AST == Aspartate aminotransferase

ALP == Alkaline Phosphatase

ACP == Acid Phosphatase

T. Protein == Total serum protein;

Contr. == Control

of ischaemic heart disease and that an elevated serum levels is expressed in individuals with atherosclerosis or a history of myocardial infarction (Kaplan and Szabo, 1983).

Total cholesterol content in the sera of chicks fed the control treatment (F) was found to be significantly higher than all the test treatments which contained different levels of MSBP ( $P < 0.05$ ). The total cholesterol ranged between 3.39 mmol/L (E) and 3.91 mmol/L (A) for the test treatments while the control value was 5.11 mmol/L. The concentration of serum LDL for the test treatments ranged between 0.83 and 1.57 mmol/L while the control was 2.69 mmol/L. On the other hand, there was no significant variation in the serum HDL levels in both the test and control treatments ( $P > 0.05$ ). Cholesterol is a normal body constituent and its level may rise to a very high level in some pathological states (Shutler *et al.*, 1987; Kaplan and Szabo, 1983). An elevated serum cholesterol concentration has been implicated as one of the key risk factors in coronary heart diseases (myocardial infarction, atherosclerosis, etc).

The marked reduction of total and LDL cholesterol of the MSBP-fed chicks as demonstrated in this study is in agreement with the results of studies conducted by the Chinese Centre for Disease Control and Prevention (CCDCP) and Peking University ([www.duqing.com](http://www.duqing.com); [www.cnif.com](http://www.cnif.com)). The conclusion drawn from their work was that soy oligopeptides could significantly decrease serum total cholesterol as well as LDL cholesterol in Wistar rats. The results of the current study also showed that the cholesterol-lowering effect of MSBP was not concentration-dependent i.e. increasing the inclusion level of MSBP did not lead to a corresponding increment or reduction of serum cholesterol.

There are varieties of risk indicators to the incidence of cardiovascular heart diseases, some of which are based on the relationship between serum LDL and HDL, total cholesterol and LDL or HDL, etc. Based on these ratios, a better judgement could be made in predicting the

predisposition to CHD. A ratio of 3.5 or less indicate an ideal situation, 4.5 carries an average risk while a ratio of 5 or more is potentially dangerous (A.D.A.M., 2005; Mayes, 2000; [www.urac.org](http://www.urac.org)). Except for the ratios obtained for chicks on treatments C and E (CHD risk 2), those obtained for the rest of the treatments were far below the ideal situation of 3.5.

#### **Serum protein and enzyme levels in broiler chicks**

The serum proteins likewise enzymes assayed in the study are displayed in Table 5. No significant difference in the concentrations of all the serum protein were found in the chicks used in the study throughout the duration of the study ( $P > 0.05$ ). For the serum total protein, the highest of 23.47 g/l was found in the control (treatment F) while the lowest of 10.02 g/l was detected in the test treatment (E) which contained the highest inclusion level of MSBP. The albumin ranged between 6.35 and 7.05 while that of globulin was between 3.83 and 17.27 g/l. Since the concentration of all the serum protein investigated were statistically similar irrespective of the presence or absence of MSBP ( $P > 0.05$ ), it therefore, seems that the liver which is the sole site for synthesizing plasma protein (except for the globulins) was not exposed to injury by the introduction of the peptide, MSBP. In effect, the serum protein levels in the chicks fed all the treatments were not beyond the 75 g/L reported by Benyoh (2002). The measurement of serum activities of a number of enzymes is helpful as an adjunct in the diagnosis and management of certain disease states. Kaplan and Szabo (1983) reported that the elevation in the serum activity of some of these enzymes may be characteristic of some disorders of the hepatobiliary system while others may be much specific because of their wide distribution in other tissues. Most enzymes are usually present in the serum at low concentration as manifested by low serum activity. However, the degree of activity increases when tissues containing these enzymes are injured. The degree of activity depends on the extent of tissue damage, prior concentration of the enzyme in the tissues as well as the time

course following the injury (Kaplan and Szabo, 1983). From Table 5, all the enzymes studied, with the exception of ALT and ALP did have serum concentrations that were similar in the tests and control ( $P>0.05$ ). Increasing the concentration of MSBP in the diet of the chicks neither increased nor reduced these serum enzymes, an indication that the organs which usually produce them were not damaged.

The level of the other two enzymes (ALT and ALP) did not follow any pattern. For example, in the case of ALP, chicks that were fed diet A (0.1% MSBP) elicited significantly higher values when compared with chicks that were fed the other test treatments as well as the control treatment ( $P<0.05$ ). On the other hand, though ALP values of chicks on treatment D (0.4% MSBP) and E (0.5% MSBP) were not significantly different from each other ( $P>0.05$ ), they were, however, significantly higher than those on treatment B (0.2% MSBP), C (0.3% MSBP) and F (control) [ $P<0.05$ ]. No reasons could be advanced at this stage to explain this trend.

#### CONCLUSION

The peptide, MSBP when used as additive at the inclusion levels of 0.1% and 0.4% markedly improved the performance of yellow feather broiler chicks when fed for a period of three weeks. There were significant ADWG, total weight gain and FCE levels in the chicks fed these two treatments when compared to the others. However, MSBP did not significantly affect the ADFI as well as the survivability of the chicks regardless of the inclusion level.

It also did not influence total lipid levels in the heart and liver, serum triglyceride, ALT, AST, ACP, total protein, albumin and globulin of the chicks used in the study. MSBP at all the levels of inclusion were found to be hypocholesterolaemic.

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