Pakistan J. Zool., pp 1-4, 2021. **DOI**: https://dx.doi.org/10.17582/journal.pjz/20200503080535

Short Communication

Impact of Corn Steep Liquor and Enzose Mixture on Growth Performance of Chicks

Nasir Ali Tauqir[1], Asim Faraz[2]*, Annamaria Passantino[3], Muhammad Asif Shahzad[1], Rana Muhammad Bilal[4], Adeel Tahir[1], Hafiz Muhammad Ishaq[2] and Abdul Waheed[2]

[1]*Department of Animal Sciences, University of Sargodha, Sargodha*
[2]*Department of Livestock and Poultry Production, Bahauddin Zakariya University, Multan*
[3]*Department of Veterinary Sciences, Polo Universitario Annunziata 98168 Messina, University of Messina, Italy*
[4]*University College of Veterinary and Animal Sciences, The Islamia University of Bahawalpur, Bahawalpur*

Article Information
Received 03 May 2020
Revised 14 June 2020
Accepted 20 June 2020
Available online 16 April 2021

Authors' Contribution
NAT designed research, finalized write up and data analysis and got the financial support from the PARB, Lahore. RMB and MAS contributed in laboratory analyses. AF and AW helped in carrying out the research and write-up. AT helped in experimental work. AP and HMI helped in preparing the article.

Key words
Corn steep liquor, Enzose, Broiler, Performance, Digestibility

ABSTRACT

Globally, poultry products have been considered as an indispensable source of animal protein and it is speculated that the demand of animal protein will be increased by 60-70% in 2050 for human consumption and much of this share will come from developing nations. This research was executed to find out the nutritional influence of corn steep liquor and enzose mixture as a non-conventional protein ingredient in day old broiler chicks. For this purpose, 42 days study was conducted using hubbard broiler chicks (n=200). The birds were divided into 5 groups containing 4 replicates having 10 chicks each. Birds were offered 5 *iso-caloric* and *isonitrogenous* broiler starter (metabolizable energy 2850 kcal/ kg; crude protein 20%) diet from day 1-21 and broiler finisher (metabolizable energy 2880 kcal/ kg; Crude protein 18%) diet from day 22-42 comprising 0, 3, 6, 9 and 12% CSL and Enzose mixture (50:50 ratio). It was that broiler fed diet B gained higher body weight ($p<0.05$) and exhibited lower feed conversion ratio as compared to other treatments. Birds fed diets B (CE3) also exhibited significantly higher nutrient digestibility and carcass characteristic as compared to other treatments. Growth responses, nutrient digestibility and carcass characteristics of birds were optimized fed 3% of CSL and Enzose mixture as compared to others.

In world meat production, the share of poultry meat is approximately 33% (FAO, 2010). Although animal protein production is going on a good pace, however demand for protein and energy source feed ingredients is rising gradually (Mengesha, 2012). In poultry production feed cost shares approximately 70% of the total cost of production (Hussein, 2017). Globally, corn and soybean meal (SBM) are most predominant conventional feed ingredients included in the majority of commercial poultry diets. The price of conventional feed ingredients is rising gradually and their irregular supply is making these item insufficient and uneconomical (Van *et al*., 2017).

In this scenario of high pricing and irregular provision of conventional feed ingredients, there is dire need to replace these costly feeds ingredients with non-conventional and economical feedstuffs which may serve the purpose successfully. Agro-industrial by-products may improve the quality of feed and reduce its cost (Olarotimi and Adu, 2017). Corn steep liquor (CSL) is one of un-traditional byproduct of corn wet-milling industry which contains almost 20% crude protein (CP) and about 50% solids. So, it can be considered as potential feed ingredient for livestock and poultry birds (Trenkle, 2003). It contains ample quantity of unidentified growth factors which may enhance the feed palatability (Waldroup and Rutherford, 1971).

Enzose is a light amber color liquid derived during corn processing. It encompasses 4% CP, 2200 kcal/kg gross energy, 86% dextrose contents, 18% lactic acid with an acidic pH (4.4) (Product Reference Guide, 2010). The data related to use of CSL and Enzose as non-conventional protein ingredient in broiler chicks is scarce. Due to inadequate scientific knowledge regarding the successful inclusion of CSL and Enzose this research was planned to access the potential of CSL and Enzose as protein and energy source in broiler chick.

Materials and methods

Hubbard broiler chicks (n=200;1 day old) with an average weight of (38-40g) were selected for a 42-day trial. Birds were distributed randomly to 5 treatment groups with 4 replicates containing 10 chicks each according to a completely randomized design.

All the groups (A, B, C, D and E) were fed with iso-caloric and isonitrogenous broiler starter (metabolizable

* Corresponding author: tauqir041@hotmail.com
0030-9923/2021/0001-0001 $ 9.00/0

energy 2850 kcal/ kg; CP 20%) feed from day 1-22 and finisher (metabolizable energy 2880 kcal/ kg; crude protein 18%) feed from day 22-42 (Table I). Group A was kept on basal diet without CSL and Enzose (Table II). Group B, C, D and E were fed with basal diet respectively containing 0, 3, 6, 9 and 12% CSL and Enzose mixture (50:50 ratio). The chemical profile of CSL is presented in (Table II). Initially a brooding temperature of 90°F was provided which gradually reduced at 5ºF per week untill it reaches to 75ºF. Feed and water were given *ad libitum* to all birds with standard managmental conditions.

Table I. Ingredient and nutrient composition of diets.

Sr. No.	Ingredients	Starter	Finisher
1	Yellow corn	39	39
2	Rice broken	19	19
3	Rice polishing's	3.88	3.88
4	Soybean meal 45%	18	18
5	Corn gluten 60%	5	5
6	Canola meal	18	18
7	Corn steep liquor	0	0
8	Enzose	0	0
9	Fish meal 60%	4	0
10	Limestone	1.2	1.3
11	DCP	1.25	1.45
12	Soya oil	0.5	0.5
13	Lysine	0.17	0.25
14	Premix (Vit, Min)	0.5	0.5
Nutrient composition			
1	Protein	21	18.4
2	Metabolizable energy (Kcal Kg^{-1})	2922	2960
3	Crude fiber	3.95	3.91
4	Lysine	1.11	0.99
5	Methionine	0.67	0.65
6	Methionine + Cystine	0.76	0.65
7	Calcium	1.05	0.91
8	Available phosphorus	0.42	0.38
9	Protein: Energy	0.1381	0.152

C, Corn steep liquor; E, Enzose mixture. Group: A control CE0; B, CE3; C, CE6; D, CE9; E, CE12; Diets A, B, C, D, E were prepared by including 0, 3, 6, 9,12% corn steep liquor. Enzose (50:50 ratio), respectively. Vit. A (IU), Vit D3 150000 (IU), Vit. E 15000 (mg), Vit. 2000 K3 (mg), Vit. thiamine (B1) 1000 (mg), Vit. riboflavin (B2) 5000 (mg), Vit. pyridoxine (B6) 1500 mg, Vit. cobalmine (B12) 1500 (mg), Vit. folic acid (B9) 500 mg, pantothenic acid (B5) 8000 (mg), Vit. niacin (b3) 15000 (mg), choline chloride 150000 (mg), manganese 15000 (mg), zinc 45000 (mg), copper 25000 (mg), potassium 2000 (mg), iodine 2000 (mg), iron 45000 (mg).

Data for feed intake, weight gain and feed conversion ratio (FCR) of the birds were recorded every week throughout the experimental period (Table III). Three birds per replicate with in each treatment (12 birds/treatment) were randomly chosen and used for total tract digestibility measurement by including 1% (Celite®) insoluble ash as an external marker during the two broiler production stages *i.e.* starter (17-19 days of age) and finisher (37-39 days of age). The fecal samples were collected to perform proximate analysis for the estimation of crude protein, crude fat and crude fiber determination (AOAC, 2010).

Table II. Chemical composition (%) of CSL and enzose.

Item %	Corn steep liquor	Enzose
Dry matter	50	70
Moisture	50	30
Protein	40	4
Fat	None	None
Fiber	None	None
Ash	10	5
Nitrogen free extract	16	None
pH	4.2	4.4
Amino acids	10.6-18	None
Lactic acid	22	18
Vitamins mg/kg	14.4	None
Specific gravity	1.25	None
Dextrose	None	86
Gross energy	(as such)	2200 Kcal/kg

(Product Reference Guide, 2010).

On day 42, two birds from each replicate within each treatment (8 birds per treatment) were randomly selected and weighed for the estimation of body weight and then slaughtered to measure the dressing percentage, thigh and breast meat yield and giblet organs weight. Dressing percentage and organ weights were calculated as:

Dressing percentage = dressed weight/live weight
Giblet organ weight= Weight of organ /100 g body weight

The recorded data for all parameters were statistically analyzed for analysis of variance under completely randomized design and differences in the means were compared by using Least Significant Difference (Steel *et al.*, 1997) test. The statistical model used for all parameters was; $Y_{ij} = \mu + \tau_j + \varepsilon_{ij}$. Where, μ was overall mean, τ_j was the effect of treatment (3 treatments) and ε_{ij} was difference within treatments (error term).

Results and discussion

The results showed highest feed intake in the birds of group B relative to control group (Table IV). Group C, D and E showed reduced feed intake. Statistical analysis revealed that broilers of group B exhibited a significantly greater weight gain as compared to other treatment groups (Table IV). Whereas, lowest weight gain was recorded in the birds of group E. A significant good feed conversion ratio was observed in the birds of group B as compared to control group A (Table IV). The results indicated that birds fed diet B (CE3) had a significantly higher dry matter, crude protein and ether extract digestibility relative to other treatment groups. However, values of crude fiber

digestibility remained statistically non-significant (Table V) among the treatments. A significantly (P<0.05) higher dressing percentage was found for birds fed diet containing CE3 and CE6 followed by control group, whereas, diets CE9 and CE12 attained the lowest values regarding this trait. Data regarding relative weight of giblet organs (liver, heart, and gizzard, kidney, spleen) of broilers of all the groups showed a non-significant difference (Table V).

It is well documented that CSL is a potential source of unidentified growth factors and highly palatable and this may be plausible reason for increased feed intake in birds fed CSL and Enzose (Shen *et al*., 1970). Moreover, present results are aligned with the findings of Waldroup and Rutherford (1971) who observed improved feed intake in the birds fed with CSL. Furthermore, Ullah *et al*. (2018) reported highest feed intake in broiler fed a diet containing medium CSL. Birds fed a basal diet fortified with concentrated corn steep showed growth promotional effects as compared to birds fed feed without this component (Creger *et al*., 1962).

This increased weight gain might be due to fact that birds eat more feed and posed better digestion and absorption, consequently leading to better growth (Simon *et al*., 1960). Broilers gained more weight when given a diet fortified with 10% corn dried steep Waldroup *et al*. (1970). The unidentified growth factors in CSL might have helped in improving the body weight of bird (Camp *et al*., 1957).

Furthermore, Batal and Parsons (2004) reported that diets containing dextrose may be applied as an effective digestible energy source. In present research the best FCR in group B may be attributed to the stimulation of gastrointestinal activity (El-Hussein *et al*., 2008). A better effect on improved body weight and FCR, confirm that dried CSL and other corn-based product like, corn dried steep liquor concentrate, corn fermentation condensed soluble and fermented corn extractives may beneficially modulate bird's growth (Waldroup *et al*., 1970). Similarly, to our finding's improvement in the FCR was recorded at an inclusion level 25% and 20 %in hen and turkey, respectively (Waldroup and Rutherford, 1971).

In comparison to control group improved nutrient digestibility in CSL based diets could be due to availability

Table III. Growth performance of broilers during the starter (day 0-21) grower (day 22-42) and overall production period fed diets containing corn steep liquor (CSL) and enzose (Enz) mixture.

Diets	Feed intake (g)			Weight gain(g)			Feed conversion ratio		
	Day 0-21	Day 22-42	Day 1-42	Day 0-21	Day 22-42	Day 1-42	Day 0-21	Day 22-42	Day 1-42
A	1112.8^{b}	2913^{a}	4025^{b}	652.68^{b}	1126.6^{b}	1779^{bc}	1.7^{a}	2.59^{a}	2.27^{b}
B	1300^{a}	2893^{a}	4193^{a}	857^{a}	1221.4^{a}	2078^{a}	1.51^{b}	2.37^{b}	2.01^{c}
C	1020.5^{cd}	2901.4^{a}	3922b^{c}	675.5^{b}	1133.4^{b}	1809^{b}	1.51^{b}	2.56^{a}	2.17^{b}
D	1062.9^{bc}	2804^{a}	3867^{c}	632^{b}	1079.3^{bc}	1711^{c}	1.68^{a}	2.6^{a}	2.26^{b}
E	982.8^{d}	2858^{a}	3841^{c}	561.9^{c}	1052^{c}	1614^{d}	1.75^{a}	2.71^{a}	2.38^{a}
SEM	16.665	35.096	37.967	14.018	21.731	27.092	0.035	0.052	0.033
L	*	N.S	*	*	*	*	*		*
Q	*	N.S	N.S	*	*	*	*		*
C	*	N.S	*	*	*	*	*		*

L, Linear; Q, Quadratic; C, Cubic; a, b, c, d column means for each effect with different superscripts show significant differences*, Significant at p<0.05; **, Significant at p<0.01

Table IV. Nutrient digestibility's of broilers during the starter (day 0-21) grower (day 22-42) production period fed diets containing corn steep liquor (CSL) and enzose (Enz).

Diets	Starter				Finisher			
	Dry matter	Crude protein	Ether extract	Crude fiber	Dry matter	Crude protein	Ether extract	Crude fiber
A	87.30b	69.00b	75.70bc	6.22	87.50^{c}	77.70^{b}	85^{c}	6.38
B	89.70a	71.30a	77.30a	5.98	91.00^{a}	79.50^{a}	87.70^{a}	6.40
C	87.80b	67.40c	76.12b	6.20	89.20^{b}	78.00^{b}	85.80^{b}	6.20
D	86.00c	66.70cd	75.32c	6.32	85.70^{d}	75.90^{c}	83.20^{d}	6.32
E	85.80c	66.20d	74.30d	6.35	85.00^{d}	75.00^{d}	82.80^{d}	6.35
SEM	0.18	0.24	0.17	0.30	0.28	7.81	0.14	0.25
L	*	*	*	N.S	*	*	*	N.S
Q	*	*	*	N.S	*	*	*	N.S
C	*	*	*	N.S	*	*	*	N.S

For abbreviations and statistical detail see Table III.

Table V. Carcass characteristics (kg) of the broilers fed diets containing corn steep liquor (CSL) and enzose (Enz) at day 42.

Diets	Starter				Finisher			
	Carcass yield	Breast yield	Thigh yield	Gizzard weight	Carcass yield	Breast yield	Thigh yield	Gizzard weight
A	70.60b	26.87a	11.11b	1.90	0.55	0.68b	2.55	0.08
B	72.30a	26.02ab	11.75a	2.21	0.51	0.85a	2.43	0.07
C	67.51c	23.48b	11.48ab	2.1	0.64	0.85a	2.31	0.07
D	67.28c	25.10ab	11.54ab	2.15	0.60	0.82a	2.53	0.06
E	65.14d	25.97ab	11.67ab	2.10	0.60	0.84a	2.39	0.06
SEM	0.43	0.91	0.18	0.15	0.04	0.03	0.13	0.008
L	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S
Q	N.S	*	N.S	N.S	N.S	*	N.S	N.S
C	70.60b	26.87a	11.11b	1.90	0.55	0.68b	2.55	0.08

For abbreviations and statistical detail see Table III.

of soluble protein contents of CSL. In present research, the overall nutrient digestibility was higher in finisher phase relative to starter one. This may be due to fact that during initial period of life pancreas and small intestine produced low digestive enzymes. The documented values regarding dressing percentage may be considered as bench mark findings as no reports were found in literature review which can describe the potential effects of CSL and Enzose mixture on broiler's carcass characteristics. The weight of giblet organs i.e., gizzard, heart, kidney, liver and spleen of broilers fed diet containing different levels of CLS: Enzose remained statistically insignificant among the treatment groups (Table V).

Conclusion

It is concluded that growth responses, nutrient digestibility and carcass characteristics of birds were optimized fed 3% of CSL and Enzose mixture as compared to others. So, it is recommended and these results could be used for future baseline in further studies of this field. The current study results are of great importance as distinguished and supportive baseline data of nutrition science. It was found optimized feeding level 3% of CSL and Enzose mixture as compared to other feeding sources to poultry and this combination could be used as new opportunity in field of nutrition.

Acknowledgments

Authors are highly thankful to Punjab Agriculture Research Board (PARB), Lahore for funding. However, the PARB management had no involvement in the study.

Statement of conflict of interest

The authors have declared no conflict of interest.

References

AOAC. 2010. *Official methods of analysis* (18th ed.). Washington, DC.

Batal, A.B. and Parsons, C.M., 2004. *Poult. Sci*. **83**: 1140-1147. https://doi.org/10.1093/ps/83.7.1140

Camp, A.A., Cartrite, H.T., Reid, B.L., Quisenberry, J.H. and Couch J.R., 1957. *Poult. Sci*., **36**: 1354-1359. https://doi.org/10.3382/ps.0361354

Creger, R.C., Zavala, M.A., Mitchell, R.H., Davies, R.E. and Couch, I.R., 1962. *Poult. Sci*., **41**: 1928-1932. https://doi.org/10.3382/ps.0411928

FAO, 2010. *The state of food and agriculture 2009: Livestock in balance*. Bernan Assoc., USA., pp. 166.

Hussein, A., 2017. *Poult. Sci*., **50**: 1863-1867.

Mengesha, M., 2011. *Asian J. Poult. Sci.*, **5**: 135-143.

Olarotimi, O.J. and Adu, O.A., 2017. *Arch.Zootec.*, **66**: 453-459. https://doi.org/10.21071/az.v66i255.2525

Product Reference Guide., 2010. *Rafhan Maize Products Co. Ltd*., Faisalabad 38060, Pakistan.

Shen, T.F., Marrett, L.E. Sunde, M.L. and Bird, H.R., 1970. *Poult. Sci*., **49**: 542-545. https://doi.org/10.3382/ps.0490542

Simon, T.L.T. and Schible, P.J., 1960. *Poult. Sci*., **39**: 251-257. https://doi.org/10.3382/ps.0390251

Steel, R.G.D., Torrie, J.H. and Dickey, D.A., 1997. *Principles and procedures of statistics. A biometrical approach*. 2nd ed. New York. McGraw-Hill.

Trenkle, A., 2003. *Relative feeding value of wet corn steep liquor when fed to finishing cattle*. Beef Reseach Report. Iowa State University.

Ullah, Z., Yousaf, M., Shami, M.M., Sharif, M. and Mahrose, K., 2018. *J. Anim. Physiol. Anim. Nutri*., **102**: 395-402. https://doi.org/10.1111/jpn.12758

Van, I.F., Eeckhaut, V., Moore, R.J., Choct, M. and Ducatelle, R., 2017. *Microb. Biotech*. **10**: 1008-1011. https://doi.org/10.1111/1751-7915.12794

Waldroup, P.W., Hillard, C.M. and Abbott, W.W., 1970. *Poult. Sci*., **49**: 1203-1208.

Waldroup, P.W. and Rutherford, H.Q., 1971. *Poult. Sci*., **50**: 1863-1867. https://doi.org/10.3382/ps.0501863