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Effect of Dietary Inclusion of Soybean Hull on Production Performance and Nutrient Digestibility During Peak Egg Production Period with Different Phases in Laying Hens

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ABSTRACT

The aim of the present study was to investigate the effect of soybean hull in the diet of laying hens on the production performance and nutrient digestibility during peak egg production period with different phases (phase-1=week 29 to 32, phase-2=week 33 to 36, and phase-3=week 37 to 40). One hundred and sixty golden misri (Brown) laying hens of age 28 weeks were brought for the experimental purpose and reared up to 40 weeks of age. All birds were divided into 4 groups with 4 replicate per group containing 10 birds per replicate and offered the corn-soybean meal diet with soybean hull (3,%, 6 %, and 9 %) respectively. Results showed that during all phases, feed intake and weight gain were ($P<0.05$) higher in the control group, while feed conversion ratio (FCR) was non-significant among all groups. Water intake during phase-1 was ($P<0.05$) higher in group D as compared to other treated groups while nonsignificant during phase-2 and 3. The average daily eggs production on weekly basis during phase-1 was calculated as non-significant while during phase-2 and 3 higher for the control group than all other groups. Hen day egg production (HDEP), mortality, and ash digestibility were recorded as non-significant, while nutrient digestibility of dry matter (DM), crude protein (CP), crude fiber (CF), and fat were recorded higher in the control group during all the three phases. It is concluded that the different levels of soybean hull in the basal diet resulted in lower production performance and nutrient digestibility than the control group.

INTRODUCTION

The poultry feed sector has become one of the most profitable businesses in recent years due to its numerous prospects and integral possibilities of earning money and services. Feed accounts for more than 70% of total production costs, so any effort to minimize feed costs could result in a large reduction in overall costs (Rojas *et al*., 2014). Aside from all of the benefits, merits, and vast investment capacity, the feed sector has several issues. Seasonal unavailability of some products is also a factor, resulting in the compelled usage of pricey items in the feed. As a result, there is an increase in the cost of production (Khurshid et al., 2017). The aim of this study was to develop feed formulation which could enhance egg production of golden laying hens. Animal nutritionists are constantly on the lookout for alternative ingredients that would provide a cushion for low-cost formulation without compromising the performance of birds and animals. To reduce feed costs, it is required to enhance scientific information for evaluating low-cost locally prevailing agro-industrial by-products in chicken feed (Thirumalaisamy *et al*., 2016).

Protein is an essential component for poultry and other animals' growth and regular physiological functions. During the starting phase, layers require 20-22% protein, 14-16% during the grower phase, and 15-18% during the finisher phase. Animal and plant protein are the most common in poultry feed (Rojas *et al*., 2014). Fish meal, meat and poultry products as animal-derived protein while soybean meal, cottonseed meal, alfalfa meal, and sunflower meal are often used as plant-based protein (Khurshid *et al*., 2017). Soybean meal is a common plant protein source among plant sources of protein. For

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soybean meal approximately 8% of the seed coat or hull, 90% of the cotyledons, and 2% of the hypocotyl axis or germ are used (Ravindran, 2013). Soybean hulls are one of the ingredients that may be found in large quantities and at very inexpensive prices on the market. Soybean hulls are shells of soybeans that fall off during processing as a byproduct of the production of oil from soybean seeds. Soybean hulls are a valuable feed for cattle and other livestock, including poultry birds, and are accessible for on-farm feeding.

Due to the efficiency of the de-hulling process (Rojas *et al*., 2014), the chemical composition of soybean hull vary, and thus the soybean hulls may contain varying amounts of celluloses (29-51%), hemicelluloses (10-25%), proteins (11-15 %), lignin (1-4 %), and pectins (4-8 %) (Mielenz *et al*., 2009). As a result, soybean hulls are primarily lignocellulose physical entities. Soybean hulls, in contrast to many other lignocellulose materials such as switchgrass or hardwood, degrade quickly (Mielenz *et al*., 2009; Yoo *et al*., 2011). Soybean hulls are not typically used in chicken diets due to their high fiber content; however, positive incorporation of soybean hulls in poultry rations has been documented (Newkirk, 2010). Till now, the use of soybean hulls in layer diet has not been thoroughly investigated particularly during the peak production phase in laying hens. So the present study was designed with the objective to determine the effect of dietary inclusion of soybean hull on production performance and nutrient digestibility during peak egg production period with different phases in the golden misri (brown) laying hens.

MATERIALS AND METHODS

Availability of experimental diets

The poultry farm of The University of Agriculture Peshawar was used for the experimental trial. Four types of experimental feed were prepared by Sadiq Brother Company Rawalpindi. Control group (A) contained corn-soybean meal (basal diet), while group B, C and D contained 3%, 6%, and 9% soybean hull+basal diet respectively (Table I).

Experimental birds

A total of 160 golden misri (brown) laying hens, aged 28 weeks, were purchased from local market. All birds were raised together under the same environmental and managemental condition at 23.8°C, and enough light (17 h each day). A vaccination program was established for the flock. Birds were divided into 4 groups (A, B, C, D) each of 40 birds and fed on feed formulation comprising of corn-soybean meal (basal diet) and soybean hull (3%, 6% and 9% for groups B, C, D, respectively). The control group (A) was fed on corn-soybean meal. The experimental diet was fed to the birds and data was collected in three phases (1, 2 and 3, where phase-1 was ranging from 29 to 32 weeks, phase-2 from 33 to 36 weeks and phase-3 ranged from 37 to 40 weeks of age).

Table I. Experimental diet compostion.

Nutrient (%)	Control	3% SH	6% SH	9% SH
Corn 12 M	53.120	52.120	51.120	49.960
Canola meal 34	4.000	4.000	4.000	5.000
Soybean meal 44	24.340	24.340	22.340	20.340
Guar meal	1.00	00	00	00
Soy hull	00	3.000	6.000	9.000
PBM Hi fat	2.000	1.020	1.020	00
Poultry oil/ fat	2.790	2.790	2.790	2.970
Salt	0.320	0.320	0.320	0.320
Sodium bicarbonate/ Soda	0.100	0.100	0.100	0.100
Limestone/ chips	11.190	11.190	11.190	11.190
DCP	0.770	0.770	0.770	0.770
DLM	0.080	0.080	0.080	0.080
Choline chloride 70	0.100	0.100	0.100	0.100
Vitamin premix broiler	0.070	0.070	0.070	0.070
Mineral premix	0.060	0.060	0.060	0.060
Phytase	0.010	0.010	0.010	0.010
Enramycin	0.020	0.020	0.020	0.020
Ethoxyquin/ antioxidant	0.010	0.010	0.010	0.010
NSPs	0.020	00	00	00

To provide one kg of diet: Retinyl acetaste, 4400 IU; DL-α-tocopheryl acetate, 12 IU; Cholecalciferol, 118µg; Thiamine, 2.5mg; Menadione sodium bisulphite, 2.40 mg; Niacin, 30mg; vit.B_2, 4.8 mg; D-pantothenic acid, 10 mg; vit. B_6, 5 mg; vit. B_7, 130 µg; Cyanocobalamine, 19 µg; vit. B_9, 2.5 mg; Mn, 85 mg; Zinc, 75 mg; Fe, 80 mg; Iodin, 1 mg; Selenium, 130 µg; Copper, 6 mg.

Performance parameters

On daily basis, egg production, water intake and feed intake was recorded. Hen day egg production (HDEP) was calculated as follows:

$$HDEP = \frac{\text{Total number of Eggs produced during the Period}}{\text{Total number of Hen} - \text{days in the same period}} \times 100$$

The feed conversion ratio (FCR) was calculated on weekly basis by dividing total feed intake by a dozen eggs. The body weight gain (BW) was calculated by subtracting the initial weight from the end weight of the body every week. The experiment's mortality rate was tracked daily, along with the reason for death determined after a postmortem examination.

Nutrient digestibility

For ileal nutrient digestibility determination, Celite (Sigma Aldrich) was added at 1 % as an indigestible marker to the basal diet. At the end of the experiment, three birds per pen were randomly selected and slaughtered. The carcass was dissected and ileal digesta was collected and stored at −20 °C for chemical analysis. After freeze-drying, all the feed and ileal digesta samples were analyzed for dry matter, crude protein, crude fiber, fat, and ash by the method described by (Hafeez *et al*., 2020) using the formula.

Apparent digestibility(%)= 100 − ((concentration of marker in feed/ concentration of marker in digesta) × (concentration of nutrient in digesta/ concentration of nutrient in feed) × 100)

RESULTS

Data on feed intake (FI), weight gain (WG), feed conversion ratio (FCR), water intake and mortality are are shown in Table II. During the experimental period (phase 1, 2 and 3), feed intake and weight gain were recorded ($P<0.05$) higher in control group as compared to other treated groups. The FCR was non-significant on weekly basis among all the groups during different phases. The water intake was $(P<0.05)$ higher in group-D as compared to other treated groups in phase1, though non significant during phase-2 and 3. Mortality rate during all phases were calculated as non-significant for all treated groups. Table III shows average daily egg production percentage on weekly basis and HDEP at different phases. During the experimental periods (phase 1, 2 and 3), at phase-2 and phase-3 total average daily egg production were recorded $(P<0.05)$ higher in control group than all other treated groups. Among all the treatment groups, HDEP on phase-1, 2, and 3 were recorded as non-significant. The nutrient digestibility is shown in Table IV. The nutrients digestibility of DM, CP, CF and fat during all phases had $(P<0.05)$ higher value in control group as compared to other treated groups. Ash digestibility during all phases was not affected among all groups.

Table II. Effect of dietary inclusion of soybean hull (SH) in the diet on feed intake and weight gain during different phases.

Parameters	Phase	Groups weeks	Control (A) 0%	B 3% SH	C 6% SH	D 9% SH	p-value
Feed intake	1	Wk29	112.6^{a}±0.32	110.9^{ab}±0.946	108.9^{b}±1.24	107.8^{b}±0.63	<0.008
		Wk30	114±0.37	112.5±1.52	112.3±1.03	110.9±1.83	0.456
		Wk31	111.4^{a}±0.21	107.5^{b}±0.48	107.6^{b}±0.40	105.7^{b}±1.53	<0.003
		Wk32	113.4^{a}±0.65	112^{ab}±1.08	110.7^{ab}±0.87	108.7^{b}±1.30	<0.034
		Total	3161.6^{a}±8.38	3101.9^{b}±10.06	3078.1^{bc}±16.41	3033.4^{c}±10.12	<0.0041
	2	Wk33	115.1±0.31	112.3±1.96	110.4±3.30	107.6±0.98	0.1068
		Wk34	112.1^{a} ±0.45	108.8^{ab} ±2.52	106.6^{ab} ±1.51	104.7^{b} ±1.59	<0.049
		Wk35	109.3^{a}±0.30	109.1^{ab}±1.32	107.5^{ab}±0.21	106.3^{b}±0.23	<0.030
		Wk36	113.1^{a}±0.48	111.6^{ab}±1.46	109^{b}±0.70	102.9^{c}±0.41	<0.004
		Total	3148.7^{a}±5.60	3093.3^{ab}±34.22	3035.5^{bc}±29.06	2952.1^{c}±11.89	<0.025
	3	Wk37	108.6^{a}±0.67	105.6^{ab}±1.91	101.7^{ab}±2.41	98.5^{b}±2.11	<0.0143
		Wk38	105.6±0.67	103.6±1.91	100.2±2.41	99.1±2.11	0.1126
		Wk39	112.2^{a}±2.52	108.2^{ab}±1.38	106.5^{ab}±1.60	103.7^{b}±1.38	<0.0363
		Wk40	110.7±2.52	110±1.38	107±1.60	105.7±1.38	0.2066
		Total	3060.7^{a}±39.75	2992.7^{ab}±39.51	2909.5^{ab}±46.99	2850.9^{b}±31.67	<0.0143
Weight gain	1	Wk29	17.2^{a}±2.567	15^{ab}±1.77	12.2^{ab}±1.31	9.7^{b}±0.85	<0.014
		Wk30	14±2.708	12±1.22	9.7±1.54	10±0.81	0.31
		Wk31	15.5±3.27	14±1.29	14±2.041	12.5±1.25	0.801
		Wk32	12.2±1.25	10±1.22	9.5±1.93	8±1.29	0.140
		Total	59^{a}±2.97	51^{ab}±1.29	45.5^{bc}±2.59	40.2^{c}±2.81	<0.004
	2	Wk33	8.2±1.10	10.5±2.10	12±1.47	11.5±2.25	0.1166
		Wk34	10±2.50	8±1.22	10.5±1.65	7.5±4.92	0.2938
		Wk35	9.5±2.10	7.3±0.75	6.7±1.37	6.8±1.19	0.0954
		Wk36	13.7^{a} ±2.68	12^{a} ±3.61	7.2^{ab} ±0.47	6^{ab}±0.91	<0.0181
		Total	41^{a}±1.47	37.50^{b}±5.31	34.50^{c}±2.90	30.50^{d}±4.40	0.0109
	3	Wk37	17^{a}±1.22	18.2^{a}±1.84	15.5^{b}±0.50	14.5^{b}±1.19	<0.0001
		Wk38	15±2.54	13.2±0.75	13.2±0.75	15.4±2.97	0.7215
		Wk39	17.7±2.65	15±1.22	18±3.76	16.2±1.10	0.6666
		Wk40	9.5^{b}±2.66	9.2^{b}±0.94	8.7^{a}±2.32	6.5^{c}±1.19	0.0025
		Total	59.2^{ab}±4.71	55.7^{a}±3.52	53.5^{b}±4.73	50.2^{c}±3.14	0.0288

Means in the same row with different superscripts are significantly different (P<0.05).

Table III. Effect of dietary inclusion of soybean hull (SH) in the diet on feed conversion ratio (FCR) during different phases.

Parameters	Phases	Groups weeks	A (0% Hull)	B (3% Hull)	C (6% Hull)	D (9% Hull)	p-value
FCR	1	Wk29	1.73±9.95	1.71±0.02	1.73±0.03	1.75±0.01	0.69
		Wk30	1.72±0.01	1.73±0.02	1.75±0.03	1.76±0.02	0.65
		Wk31	1.71±0.02	1.68±0.01	1.70±0.01	1.72±0.03	0.70
		Wk32	1.70±0.01	1.72±0.02	1.73±0.02	1.75±0.02	0.54
		Total	1.72±0.01	1.71±0.01	1.73±0.02	1.75±0.01	0.38
	2	Wk33	1.84±0.02	1.86±0.05	1.86±0.06	1.88±0.03	0.9410
		Wk34	1.77±0.02	1.80±0.05	1.82±0.06	1.84±0.04	0.8184
		Wk35	1.73±0.02	1.75±0.04	1.76±0.02	1.79±0.02	0.6305
		Wk36	1.79±0.02	1.83±0.02	1.85±0.02	1.87±0.01	0.1145
		Total	1.78±0.01	1.81±0.03	1.82±0.02	1.84±0.04	0.3701
	3	Wk37	1.77±0.01	1.77±0.05	1.76±0.06	1.79±0.04	0.9823
		Wk38	1.76±0.01	1.75±0.04	1.77±0.05	1.79±0.02	0.9148
		Wk39	1.84±0.05	1.79±0.01	1.80±0.03	1.87±0.02	0.3863
		Wk40	1.85±0.05	1.82±0.03	1.84±0.03	1.90±0.03	0.6205
		Total	1.80±0.03	1.78±0.02	1.79±0.04	1.83±0.02	0.6903

Means in the same row with different superscripts are significantly different (P<0.05).

Table IV. Effect of dietary inclusion of soybean hull (SH) in the diet on water intake and mortality during different phases.

Parameter	Phases	Groups weeks	A (0% Hull)	B (3% Hull)	C (6% Hull)	D (9% Hull)	p-value
Water intake	1	Wk29	170.5±2.90	174.2±2.81	177.7±3.03	181.2±2.13	0.0820
		Wk30	173.2^{a}±1.70	177.7^{ab}±2.78	182.2^{ab}±2.01	185^{b}±2.38	<0.01
		Wk31	178.7^{a}±1.37	184^{ab}±2.73	189.5^{bc}±1.93	193.7^{c}±1.88	<0.001
		Wk32	176.5^{a}±3.37	180^{ab}±2.34	185.2^{ab}±3.49	190.7^{b}±2.65	<0.0210
		Total	176.6^{a}±0.82	179^{ab}±1.48	183.6^{bc}±2.05	187.6^{c}±1.20	<0.0008
	2	Wk33	178.4±2.73	181.4±4.20	175.8±6	177.3±3.68	0.9984
		Wk34	184.1±0.66	186.2±5.40	181.2±2.84	185.9±2.68	0.9758
		Wk35	180.6±1.03	183.5±5.37	174.6±1.57	178.9±4.64	0.8971
		Wk36	189.0±0.77	190±2.35	183.3±3.31	186±4.29	0.8559
		Total	183±0.86	185.2±2.23	178.7±1.86	182.2±2.83	0.8422
	3	Wk37	186.9±1.07	184.5±3.06	183.9±3.86	180.9±3.39	0.8083
		Wk38	180.1±0.57	177.9±2.66	175.3±3.61	173.8±5.17	0.9933
		Wk39	183.6±4.04	181.5±3.53	179.7±2.56	176.2±2.21	0.9295
		Wk40	193.7±1.74	190.9±1.33	187.8±3.64	185.1±4.87	0.9429
		Total	186.1±0.83	183.7±0.56	181.6±2.60	179.5±1.41	0.6737
Mortality	1		0.25±0.25	0.25±0.25	0.50±0.28	0.50±0.28	0.831
	2		0.00±0.00	0.00±0.00	0.25±0.25	0.25±0.25	0.5885
	3		0.00±0.00	0.00±0.00	0.25±0.25	0.25±0.25	0.5885

Means in the same row with different superscripts are significantly different (P<0.05).

Table V. Effect of dietary inclusion of soybean hull (SH) in the diet on average daily egg production on weekly basis and Hen day egg production during different phases.

Parameter	Phases	Groups weeks	A (0% Hull)	B (3% Hull)	C (6% Hull)	D (9% Hull)	p-value
Avg daily egg production (%)	1	Wk29	76.8a±0.41	76.3a±0.92	75.3ab±0.68	74.9b±0.68	<0.0039
		Wk30	77.2^{a}±0.41	76.8^{ab}±0.41	76.7^{bc}±0.68	75.3^{c}±0.68	<0.0225
		Wk31	76.2^{a}±0.89	75.4^{ab}±0.41	75.7^{ab}±0.58	74.5^{b}±0.92	<0.0062
		Wk32	77.6^{a}±0.35	77.4^{ab}±0.41	76.2^{b}±0.68	74.2^{c}±0.58	<0.0301
		Phase1Total	76.2±0.42	76.5±0.29	75.4±0.51	75.2±0.52	0.0631
	2	Wk33	75^{a}±0.92	74.5^{a}±1.07	74^{c}±1.07	73.5^{c}±0.58	<0.0030
		Wk34	75.7^{a}±1.01	74.5^{ab}±0.89	74.3^{b}±1.58	73.2^{b}±1.07	<0.0444
		Wk35	75.4±0.82	74.6±1.21	73.2±1.21	73±1.21	0.0656
		Wk36	75.7^{a} ±1.16	73.8^{ab}±0.82	73.5^{ab}±1.23	72^{c}±0.68	<0.0022
		Phase2 total	75.5^{a}±0.53	74.1^{b}±0.74	73.8^{c}±0.26	73.5^{c}±0.08	<0.042
	3	Wk37	74.5^{a}±0.92	73.4^{ab}±1.30	73.2^{ab}±0.92	72^{c}±0.68	<0.0011
		Wk38	74.7^{a}±1.07	73^{ab}±1.21	73.8^{ab}±0.71	72.4^{b}±0.71	<0.0052
		Wk39	74.2^{a}±1.07	73.5^{a}±1.07	72.7^{b}±0.92	71.4^{b}±0.41	<0.0009
		Wk40	73.4^{a}±0.89	72.5^{a}±1.21	71.6^{a}±1.21	70.7^{b}±0.35	<0.0065
		Phase3total	74.5^{a}±0.76	73.8^{ab}±0.33	72.7^{b}±0.89	72.4^{c}±0.38	<0.046
Hen day egg production %	1		80.9±1.88	79.6±2.17	80.3±2.44	78.4±2.55	0.877
	2		75.5±0.53	73.1±0.74	73.3±2.15	70.3±1.93	0.179
	3		72.5±0.76	71.8±0.33	71.3±2.20	68.2±1.61	0.2046

Means in the same row with different superscripts are significantly different (P<0.05).

Table VI. Effect of dietary inclusion of soybean hull (SH) in the diet on nutrient digestibility during different phases.

Groups parameters (%)	Phases	A (0% SH)	B (3% SH)	C (6% SH)	D (9% SH)	P-value
DM	1	77.96^{a}±0.79	76.37^{ab}±0.46	75.69^{ab}±0.39	75.250^{b}±0.75	<0.0469
CP		67.88^{a}±0.38	65.69^{ab}±0.50	64.62^{b}±0.38	64.24^{b}±1.32	≤0.0223
CF		70.82^{a}±0.65	69.15^{a}±1.27	66.72^{b}±0.52	64.18^{c}±1.00	<0.0005
Fat		76.62^{a}±0.81	75.83^{ab}±0.43	74.58^{ab}±0.97	72.57^{b}±1.17	<0.0367
Ash		57.12±0.76	57.69±0.85	59.12±0.90	60.58±1.22	0.3145
DM	2	79.96a±0.79	78.87ab±0.46	77.69ab±0.39	76.75b±0.75	<0.0043
CP		70.88a±0.38	68.69ab±0.50	66.42b±0.38	66.24b±1.32	<0.0223
CF		72.12a±0.65	71.15a±1.27	68.22b±0.52	66.18c±1.01	<0.0003
Fat		78.12±0.81	77.13±0.43	75.98±0.97	75.57±1.17	0.0944
Ash		60.32±0.76	61.89±0.85	62.22±0.90	62.68±1.22	0.2813
DM	3	81.46ab±0.73	80.37ab±0.59	78.64b±0.58	77.52b±0.44	<0.0068
CP		72.01a±0.98	71.48ab±1.24	69.25b±0.98	68.29b±1.21	0.0154
CF		74.14a±1.06	72.13ab±0.98	70.19bc±0.50	68.38c±0.58	<0.0020
Fat		79.12±0.87	78.13±0.91	76.88±1.13	76.72±0.94	0.0927
Ash		58.39±0.77	58.64±0.58	60.12±0.64	61.23±1.05	0.6662

Means in the same row with different superscripts are significantly different (P<0.05).

DISCUSSION

The effect of soybean hull in different levels (3, 6, and 9%) in the diet of golden misri (brown) laying hens were determined on the production performance and nutrient digestibility during peak egg production period with different phases (phase-1= week 29 to 32, phase-2= week 33 to 36, and phase-3= week 37 to 40). FI and WG were lower in the soybean hulls group than the control group during all three phases. Similar to the present study result Tejeda and Kim (2020) reported lower FI and WG in the broiler on dietary supplementation of soybean hulls in broiler at different levels in feed. The result is also in agreement with the finding of Esonu *et al*. (2005) who presented lower WG in laying hens for 10, 20, and 30% soybean hull in the diet while lower FI for 10% soy hull in feed as compared to control. Jiménez-Moreno *et al*. (2011) also described linearly reduced average daily WG in broiler from 1 to 12 days with an increased level of the fiber sources from 2.5 to 7.5%. High fiber diets usually mean relatively low energy density that may decrease FI, FCR, and BWG of poultry (Gonzalez-Alvarado *et al*., 2007). Soybean hull contains both soluble and insoluble fiber, and there are a variety of reasons why adding more than 4% crude fiber to a diet can reduce growth performance, especially when soluble dietary fibers are included (Gonzalez-Alvarado *et al*., 2007), which is similar to the findings in the present study. Contrary to the present results Saraee *et al*. (2014) reported no effect on weight gain in broiler when provided oil and tea leaves in feed with different levels. Present results showed ($p<0.05$) higher average daily egg production in the control group during the experimental phases (phase-2 and 3) than soybean hull treatment groups. Similar to present findings Roberts *et al*. (2007) recorded decreased egg production percentage in laying hen during different phases in the group containing 4.8 % soybean hull. Contrary to the present result Lumpkins *et al*. (2005) recorded no effect on egg production when fed laying hens high-fiber (low CP) diets. The addition of high-fiber feed components to pig or poultry diets reduce nutritional digestion (Dilger *et al*., 2004; Hogberg and Lindberg, 2004), and similarly in the present study low egg production in the soybean hull containing diet groups is mainly due to low FI and poor nutrient digestibility.

Whether the water intake increases or decreases depends on the nature of the dietary fiber. The present study results showed that the (WI) was ($P>0.05$) higher in soybean hull groups during phase1, which is similar to the finding of Jiménez-Moreno *et al*. (2016) who reported an increase in water intake in broilers from day 18 to 20 on feeding oat hulls, rice hulls, and sunflower hulls as dietary fiber both in mash and pellet form at the level of 2.5 % and 5% in feed. Water use is strongly linked to feeding consumption (Schoorlemmer and Evered, 2002; Jiménez-Moreno *et al*., 2016). Under mild temperature conditions, broiler water intake is around twice as much as feed consumption on a weight basis (NRC, 1994). However, environmental temperature, feed composition, and the physico-chemical properties of the various components and ingredients of the di*et al*l have an impact on this relationship (Francesch and Brufau, 2004; Carré *et al*., 2013). According to Garca *et al*. (2008), 21-day-old broilers fed barley had a 10% higher water intake (92 vs. 102 g/d) than broilers fed corn, indicating that the higher soluble fiber content of the barley was responsible for the increase observed, which is similar to the findings of the present study and the soluble fiber portion of soybean hulls is responsible for increasing water consumption in the soy hulls treated groups.

When fibers are administered in excessive quantities, they can interfere with nutritional absorption, resulting in lower performance (Cao *et al*., 2003). Hetland *et al*. (2004), Gonz'alez-Alvarado *et al*. (2008), Svihus (2011) and Rezaei *et al*. (2018) found that having more dietary fiber in the gastrointestinal tract increases organ size (i.e., gizzard, intestines) to compensate for the increased volume (i.e., bulky diets) of feed moving through the intestines. Changes in organ growth may increase maintenance requirements associated with increases in tissue synthesis and protein turnover, resulting in more nutrients being directed toward maintaining such tissues and less toward muscle protein accretion and growth performance even when adequate nutrient absorption is occurring in the gastrointestinal tract (Nyachoti *et al*., 2000). According to Cao *et al*. (2003) when fed 10% cellulose, laying hens exhibited poorer nitrogen digestion and absorption. Both soluble and insoluble fiber components can be found in soybean hull. The viscous components of soluble fibers have been shown to lower dry matter apparent digestibility coefficients. According to Silva *et al*. (2013) broilers given pectin in increasing levels from 10 to 50 g/kg had a quadratic and linear response in the starter and grower stages, respectively; increased pectin resulted in poorer dry matter digestibility, which is similar to the current study's findings. Another study by Shakouri *et al*. (2009) found that birds given grains containing soluble and viscous non-starch polysaccharides had decreased apparent dry matter digestibility, which they attributed to the soluble fraction of the fiber components. Sklan *et al*. (2003) observed reduced digestibility of crude protein, fat, and gross energy in turkeys fed 8 to 9 percent CF in diets using sunflower meal as the primary source of dietary fiber which is similar to the findings in the current study. Soluble dietary fiber (DF) is hypothesized to enhance intestinal viscosity, which is linked to changes in intestinal microbiota, as well as decreased nutritional absorption and digestibility (Tejeda and Kim, 2021). Because of their impact on passage rate in the small intestines and fermentability in the hindgut, solubility and fermentability are two of the most notable parameters impacting nutrient digestion efficiency in the presence of soluble fiber (Davir *et al*., 2000; Kheravii *et al*., 2018).

CONCLUSION

With current soybean hull levels in feed, growth performance and nutrient digestibility were not favored during different phases, which could be linked to an increase in nutrient requirements for maintaining a higher epithelial cell turnover. The 3% soybean hulls group had a better result for production performance parameters and nutrient digestibility as compared to 9% soybean hull containing group. Fiber type and level of inclusion are important variables in controlling growth, intestinal development, and nutrient digestion, and further research is needed to understand how different fiber components alter layer performance from a physiological and nutritional viewpoint. This will lay the foundation for the feed industry to create cost-effective diets using low-cost fibrous feedstuffs for poultry industry.

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Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Cao, B., Zhang, X., Guo, Y., Karasawa, Y., and Kumao, T., 2003. Effects of dietary cellulose levels on growth, nitrogen utilization, retention time of diets in digestive tract and caecal microflora of chickens. *Asian Austral. J. Anim. Sci*., **16:** 863-866. https://doi.org/10.5713/ajas.2003.863

Carré, B., Lessire, M., and Juin, H., 2013. Prediction of metabolisable energy value of broiler diets and water excretion from dietary chemical analyses. *Animal*, **7:** 1246-1258. https://doi.org/10.1017/S1751731113000359

Dilger, R., Sands, J., Ragland, D., and Adeola, O., 2004. Digestibility of nitrogen and amino acids in soybean meal with added soyhulls. *J. Anim. Sci*., **82:** 715-724. https://doi.org/10.2527/2004.823715x

Dvir, I., Chayoth, R., Sod-Moriah, U., Shany, S., Nyska, A., Stark, A.H., Madar, Z., and Arad, S.M., 2000. Soluble polysaccharide and biomass of red microalga Porphyridium sp. alter intestinal morphology and reduce serum cholesterol in rats. *Br. J. Nutr*., **84:** 469-476. https://doi.org/10.1017/S000711450000177X

Esonu, B., Izukanne, R., Inyang, O., 2005. Evaluation of cellulolytic enzyme supplementation on production indices and nutrient utilization of laying hens fed soybean hull-based diets. *Int. J. Poul. Sci*., **4:** 213-216. https://doi.org/10.3923/ijps.2005.213.216

Francesch, M., and Brufau, J., 2004. Nutritional factors affecting excreta/litter moisture and quality. *Worlds Poult. Sci. J*., **60:** 64-75. https://doi.org/10.1079/WPS20035

García, M., Lázaro, R., Latorre, M., Gracia, M., and Mateos, G., 2008. Influence of enzyme supplementation and heat processing of barley on digestive traits and productive performance of broilers. *Poult. Sci*., **87:** 940-948. https://doi.org/10.3382/ps.2007-00266

González-Alvarado, J., Jiménez-Moreno, E., Lázaro, R., and Mateos, G., 2007. Effect of type of cereal, heat processing of the cereal, and inclusion of fiber in the diet on productive performance and digestive traits of broilers. *Poult. Sci*., **86**: 1705-1715. https://doi.org/10.1093/ps/86.8.1705

González-Alvarado, J., Jiménez-Moreno, E., Valencia, D., Lázaro, R., and Mateos, G., 2008. Effects of fiber source and heat processing of the cereal on the development and pH of the gastrointestinal tract of broilers fed diets based on corn or rice. *Poult. Sci*., **87:** 1779-1795. https://doi.org/10.3382/ps.2008-00070

Hafeez, A., Sohail, M., Ahmad, A., Shah, M., Din, S., Khan, I., and Khan, R.U., 2020. Selected herbal plants showing enhanced growth performance, ileal digestibility, bone strength and blood metabolites in broilers. *J. appl. Anim. Res*., **48**: 448-453. https://doi.org/10.1080/09712119.2020.1818569

Hetland, H., Choct, M., and Svihus, B., 2004. Role of insoluble non-starch polysaccharides in poultry nutrition. *Worlds Poult. Sci. J*., **60:** 415-422. https://doi.org/10.1079/WPS200325

Högberg, A., and Lindberg, J.E., 2004. Influence of cereal non-starch polysaccharides on digestion site and gut environment in growing pigs. *Live Prod. Sci*., **87:** 121-130. https://doi.org/10.1016/j.livprodsci.2003.10.002

Jiménez, M.E., Romero, C., Berrocoso, J., Frikha, M., and Gonzalez M.G., 2011. Effects of the inclusion of oat hulls or sugar beet pulp in the diet on gizzard characteristics, apparent ileal digestibility of nutrients, and microbial count in the ceca in 36 day old broilers reared on floor. In: 100 th Annual Meeting Poultry Science Association (16/07/2011 - 19/07/2011) St. Louis, EEUU. https://oa.upm.es/12589/

Jiménez-Moreno, E., de Coca-Sinova, A., González-Alvarado, J., and Mateos, G., 2016. Inclusion of insoluble fiber sources in mash or pellet diets for young broilers. 1. Effects on growth performance and water intake. *Poult. Sci*., **95:** 41-52. https://doi.org/10.3382/ps/pev309

Kheravii, S., Morgan, N., Swick, R.A., Choct, M., and Wu, S.-B., 2018. Roles of dietary fiber and ingredient particle size in broiler nutrition. *Worlds Poult. Sci. J*., **74:** 301-316. https://doi.org/10.1017/S0043933918000259

Khurshid, H.D., Baig, S., Ahmad, J., Muhammad, A., and Khan, M.A., 2017. Miracle crop: The present and future of soybean production in Pakistan. *MOJ Biol. Med*., **2:** 189-191. https://doi.org/10.15406/mojbm.2017.02.00042

Lumpkins, B., Batal, A., and Dale, N., 2005. Use of distillers dried grains plus solubles in laying hen diets. *J. appl. Poult. Res*., **14:** 25-31. https://doi.org/10.1093/japr/14.1.25

Mielenz, J.R., Bardsley, J.S., and Wyman, C.E., 2009. Fermentation of soybean hulls to ethanol while preserving protein value. *Bioresour. Technol*., **100:** 3532-3539. https://doi.org/10.1016/j.biortech.2009.02.044

Newkirk, R., 2010. *Soybean: Feed industry guide*. 1st edition, Canadian International Grains Institute. (http://www.cigi.ca/pdfs/2010%20Soybean%20Feed%20Industry%20Guide.pdf).

NRC (National Research Council), 1994. *Nutrient requirements of poultry*: Ninth edition. Washington, DC: The National Academies Press. https://doi.org/10.17226/2114

Nyachoti, C.M., de Lange, C.F., McBride, B.W., Leeson, S., and Gabert, V.M., 2000. Endogenous gut nitrogen losses in growing pigs are not caused by increased protein synthesis rates in the small intestine. *J. Nutr*., **130:** 566-572. https://doi.org/10.1093/jn/130.3.566

Ravindran, V., 2013. *Main ingredients used in poultry feed formulations*. Poultry development review (ed.) FAO, 67-69. https://scholar.cu.edu.eg/wafaaabdelghany/files/book_41.pdf#page=66

Rezaei, M., Karimi Torshizi, M., Wall, H., and Ivarsson, E., 2018. Body growth, intestinal morphology and microflora of quail on diets supplemented with micronised wheat fiber. *Br. Poult. Sci*., **59:** 422-429. https://doi.org/10.1080/00071668.2018.1460461

Roberts, S.A., Xin, H., Kerr, B.J., Russell, J.R., and Bregendahl, K., 2007. Effects of dietary fiber and reduced crude protein on nitrogen balance and egg production in laying hens. *Poult. Sci*., **86:** 1716-1725. https://doi.org/10.1093/ps/86.8.1716

Rojas, M.J., Siqueira, P.F., Miranda, L.C., Tardioli, P.W. and Giordano, R.L., 2014. Sequential proteolysis and cellulolytic hydrolysis of soybean hulls for oligopeptides and ethanol production. *Ind. Crops Prod.,* **61**: 202-210. https://doi.org/10.1016/j.indcrop.2014.07.002

Saraee, M.H.A., Seidavi, A., Dadashbeiki, M., Laudadio, V., and Tufarelli, V., 2014. Effect of dietary supplementation with different levels of green tea powder and fish oil or their combination on carcass characteristics in broiler chickens. *Pakistan J. Zool*., **46**: 1767-1773. http://www.zsp.com.pk/pdf46/1767-1773.

Schoorlemmer, G.H., and Evered, M.D., 2002. Reduced feeding during water deprivation depends on hydration of the gut. *Am. J. Physiol. Regulat. Integ. Comp. Phys*., **283:** R1061-R1069. https://doi.org/10.1152/ajpregu.00236.2002

Shakouri, M., Iji, P., Mikkelsen, L.L., and Cowieson, A., 2009. Intestinal function and gut microflora of broiler chickens as influenced by cereal grains and microbial enzyme supplementation. *J. Anim. Physiol. Anim. Nutr*., **93:** 647-658. https://doi.org/10.1111/j.1439-0396.2008.00852.x

Silva, V.K., Morita, V.D.S., and Boleli, I.C., 2013. Effect of pectin extracted from citrus pulp on digesta characteristics and nutrient digestibility in broilers chickens. *Rev. Brasil. Zoot*., **42**: 575-583. https://doi.org/10.1590/S1516-35982013000800007

Sklan, D., Smirnov, A., and Plavnik, I., 2003. The effect of dietary fibre on the small intestines and apparent digestion in the turkey. *Br. Poult. Sci*., **44:** 735-740. https://doi.org/10.1080/00071660310001643750

Svihus, B., 2011. The gizzard function, influence of diet structure, and effects on nutrient availability. *Worlds Poult. Sci. J*., **67:** 207-224. https://doi.org/10.1017/S0043933911000249

Tejeda, O., and Kim, W., 2020. The effects of cellulose and soybean hulls as sources of dietary fiber on the growth performance, organ growth, gut histomorphology, and nutrient digestibility of broiler chickens. *Poult. Sci.*, **99:** 6828-6836. https://doi.org/10.1016/j.psj.2020.08.081

Tejeda, O., Kim, K.W., 2021. Role of dietary fiber in poultry nutrition. *Animal*, **11:** 461. https://doi.org/10.3390/ani11020461

Thirumalaisamy, G., Muralidharan, S., Senthilkumar, R., Hema, S., and Priyadharsini, M., 2016. Cost-effective feeding of poultry. *Int. J. Sci. environ. Technol*., **5:** 3997-4005.

Yoo, J., Alavi, S., Vadlani, P., and Amanor-Boadu, V., 2011. Thermo-mechanical extrusion pretreatment for conversion of soybean hulls to fermentable sugars. *Bioresour. Technol*., **102:** 7583-7590. https://doi.org/10.1016/j.biortech.2011.04.092