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Growth Performance and Egg Quality of Laying Hens Fed with Diet Supplemented with Date Palm Seed Powder

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Abstract:

An experiment lasting 12 weeks was conducted to assess the growth performance and egg quality of laying hens fed a diet supplemented with date palm seed powder. 250-30-week-old Lohman brown layers weighing 1550.2 ± 0.62 grammes were acquired from a Gujarat breeding farm and randomly assigned to five treatments with five replicates (10 birds per replicate). The investigation lasted 84 days and used a completely randomised design. The diet was a basal diet (corn-soya meal based), which is compatible with the Nutritional Research Council's advice from 1994. Hens in treatment 1 were fed a basal diet without date palm seed powder, whereas those in treatments 2, 3, 4, and 5 were administered a basal diet with date palm seed powder at 20 g, 40 g, 60 g, and 80 g per kg, respectively. Birds have limitless access to fresh, clean water and food. The phyto-constituents discovered in date palm seed powder were phenols (891.44 mg/g), flavonoids (572.09 mg/g), tannins (65.56 mg/g), alkaloids (165.2 mg/g), terpenoids (332.8 mg/g), saponins (90.51 mg/g), and steroids (78.66 mg/g). Date palm powder treatment resulted in increased average daily weight gain, feed intake, hen day house production, and hen housed egg production ($p < 0.05$) compared to the control group. Supplementing with date palm seed powder decreased the feed conversion ratio from 4.69 to 5.05 ($p < 0.05$). The treatment had a substantial impact on egg weight (47.12 to 57.03 g), breadth and length (35.04 - 43.87 mm; 38.81 - 47.23 mm), shell thickness (0.19 - 0.35 mm), yolk colour (3.13 - 11.23), and haugh unit. It was determined that date seed powder can be supplemented at a rate of up to 80 g/kg diet to increase performance and yolk quality metrics when compared to hens fed a control diet, with no adverse impacts on their health state.

Key words: date palm; seed; phytochemicals; hens; food safety

Introduction

When it comes to feed additives (plant extracts, enzymes, pro- and prebiotics, organic acids, and many more), the livestock industry is flooded with options that not only improve animal performance and profitability, but also improve feed and animal-derived product quality (Mojca, 2020; Alagbe, 2023). In this context, phytogenic feed additives are expected to have a bright future in animal nutrition due to their diverse efficacies and effects on sustainability and safety (Jan and Ester, 2021; John, 2024). Phytogenics are abundant in phytochemicals or bioactive compounds that performs numerous biological or pharmacological activities viz; anti-inflammatory, antioxidant, anti-fungal, anti-viral, anti-helminthic (Musa et al., 2020), immune-stimulatory, hepato-protective (Okwu and Iroabuchi, 2009), cardio-protective and antimicrobial (Alagbe et al., 2020; Singh et al., 2022).

Phoenix dactylifera is a palm plant that belongs to the Aracaceae family. The tree is widespread in the Canary Islands, Northern Africa, Arabia, and various parts of Asia, including Pakistan and India (Nehdi et al., 2020). Date trees can withstand exceptionally high temperatures and will not wither when growing in full sunshine, thus they thrive even in the desert (Dada et al., 2012). It is grown for its sweet fruits and seeds, which can be powdered and used as tea (Mustafa et al., 1993). Dates contain numerous phytochemicals such as flavonoids, terpenoids, phenols, alkaloids, steroids amongst others which contribute to the fruit's antioxidant activity, anti-viral, antimutagenic, immune-stimulatory, gastro-protective, hepato-protective, cytotoxic and anticancer activities (Assirey, 2015; Sanusi et al., 2016).

Date seeds are loaded with essential minerals viz; calcium, phosphorus, potassium, sodium, magnesium, manganese, zinc, cobalt, copper and iron in varying concentrations (Assirey, 2015). They are also rich in vitamin A, vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin C (ascorbic acid), vitamin E, vitamin K and folate (Abdulrahman et al., 2020; Kuras et al., 2020). Scientific reports has shown that date seeds contain between 71.9 - 73.4 % of carbohydrate, 5.0 - 6.3 % protein, 9.90 - 13.5 % crude fat, 6.40 - 11. 5 % crude fiber, 1.00 - 1.80 of ash and amino acids such as, glutamic acid (16.44 g/100 g), phenylalanine (5.93 g/100 g), and leucine (6.10 g/100 g), aspartic acid (1.72 g/10 g), alanine (1.2 g/100 g), and tyrosine (1.2 g/100 g), leucine (1.7 g/100 g), lysine (1.1 g/100 g), and phenylalanine (1.08 g/100 g) (Niazi et al., 2017; Agboola and Adejumo, 2013). Based on the different nutritional values present in date seeds, it can be used as an immune booster, analgesics to relief pain and protection

against diseases such as cancer and other heart related diseases (Ali et al., 2012; Dada et al., 2012).

It has been well-documented that dietary inclusion of phytogenic extracts could improve poultry performance by increasing digestive enzyme secretion (Ahmad et al., 2016), lowering the number of harmful bacteria in the digestive tract (Yalçın et al., 2012), modulating intestinal morphology functions, and positively affecting productivity, blood metabolites, immunological, antioxidant status and egg quality of laying hens (Denli et al., 2004; Gerzilov et al., 2015). However, there is scanty information on the dietary supplementation of date palm powder on the performance and egg quality of laying hens. This research will help to address the rising cases of multi-drug resistance, promote animal sustainability and food safety.

Therefore, this research was designed to evaluate the growth performance and egg quality of laying hens fed with diet supplemented with date palm seed powder.

Materials and methods

Description of experimental area, ethical approval and processing of date palm seed powder

Sumitra Research Institute, Gujarat located between 28º 20' N and 75º 30' East India was used for experiment. All experimental guidelines and procedures were approved by the ethics committee of Animal Nutrition and Biochemistry department of the Institute (AF/2023D/0010). Fresh dates were harvested within Sumitra Research Institute's environment and sent to the crop protection department for proper authentication by certified taxonomist before it was assigned an identification number (DG/2023C/DDR). Thereafter, seeds were manually removed from the fruit, washed with running tap water, sundried for 14 days until seeds become light brown and a constant weight was achieved. Dried date palm seeds were blended into powder with an electric blender and stored in an air tight labeled container for further examination in the laboratory.

Animal management and experimental design

The experiment was carried out at the Poultry section of Sumitra Research Institute, Gujarat using 250 - 30 weeks Lohman brown layers with an initial body weight of 1550.2 ± 0.62 grams were purchased from a breeding farm in Gujarat. On arrival, birds were kept in battery cages and randomly distributed into five treatments with five replicates (10 birds per replicate). Birds were acclimatized for 2 weeks, dewormed with Oramectin Plus® and fed basal diet (Corn-soya meal based diet) which is consistent with the recommendation of Nutritional Research Council in 1994 as presented in Table 1. After the adjustment period, birds in treatment 1 (T1) received basal diet without date palm seed powder while those in treatment 2, 3, 4 and 5 received same diet supplemented with date palm seed powder at 20 g, 40 g, 60 g and 80 g per kg in that order. Hens had free access to clean fresh water and feed which was given thrice daily between 6:00 H, 11:00 H and 14:00 H. Other health precautions and sanitary measures were also taken throughout the 12 weeks experimental period.

Data collection

Performance variables

Body weight gain was calculated as the difference between the final body weight and initial body weight. Measurement was carried out using a digital weighing scale

Average daily weight gain was calculated as mean weight gain divided by number of experimental days.

Feed intake was determined as the difference between the feed offered and refused.

Average daily feed intake was estimated by dividing the total feed intake divided by the period of experimental days

Feed conversion ratio (feed consumed to produce a unit of gain) was computed as the ratio of average feed consumption to average body weight gain

Mortality recorded it occurs throughout the experimental period and mortality percentage was calculated as number of dead birds divide by number of total birds multiplied by one hundred

Hen day egg production and hen house egg production

Eggs were collected thrice daily from each pen at 0900, 1300 and 1600 hours.

Hen-day egg production (HDEP) and hen housed egg production as percentage were computed using the formula below:

% HDPP = total number of eggs produced/total number of hens present on that day multiplied by hundred

% HHPP = total number of eggs produced/number of hens originally housed multiplied by hundred

Measurement of egg quality parameters

On the final day of the study, 15 eggs were randomly selected from each replicate for quality examination. The egg weight was measured with a digital sensitive scale, and the shell weight, shell thickness, yolk colour, yolk weight, yolk length, yolk height, yolk index, albumen weight, albumen height, and Haugh unit were calculated by breaking each egg on a neat level glass and separating each of the above components. The shell, albumen, and yolk were meticulously separated and weighed separately on a delicate balance with a precision of 0.01 grammes. A digital micrometre was used to determine shell thickness by taking the average of the egg's blunt, middle, and sharp points. Albumen and yolk heights were measured using a tripod micrometre gauge.

Yolk color was accessed by comparing the color of properly mixed yolk sample with the color strips of Roche color fan measurement, which is made up of 1-15 strips ranging from pale to orange yellow in color.

Haugh unit was estimated using the formula (100 log10 (h + 7.57 − 1.7w0.37 where; h = observed albumen height (expressed in mm), w = weight of egg (expressed in grams).

Length and width of the egg and the length of yolk were measured by using digital caliper expressed in mm.

Analysis of phytochemicals in date palm seed powder

Phytochemical components in date palm seed powder were analyzed according to the procedures outlined by Alagbe (2024); Alagbe (2021). 200 grams of date palm seed powder was injected into an automated gas chromatograph - mass spectrometry (GC-MS). Quantification of each phyto-constituents was determined at different optical densities; was used for each analysis and each constituent were recorded at different optical density (alkaloids, 310 nm), flavonoids (455 nm), terpenoids (350 nm), tannins (470 nm), steroids (550 nm) and phenols (670 nm). The machine was maintained at an inlet temperature of 450 ℃, column temperature (4 – 450 ℃, pressure range (0 – 100 psi ± 0.002 psi) and heating rate up to 1201/min while the mass spectrometer unit is adjusted at an ion source temperature (100 – 350 ℃), stability (± 0.10 amu/48 hours), mass range (1.5 – 1000 amu), scan rate (up to 10000 amu/sec) and ionization energy (5 eV – 250 eV).

Chemical analysis of experimental diet

Proximate composition of experimental diet was carried out using diode array based near infra-red reflectance and Trans- reflectance analyzer (Model NIRSTM DA 1680). 100 g of feed sample was passed through the cylindrical plastic collector and the machine was maintained at an optical bandwidth (8.75 nm), spectral resolution (1.0 nm), absorbance ranges (up to 2 AU), wavelength accuracy (less than 0.05 nm), photometric noise (400 – 700 nm less 50 micro au; 700 – 2500 nm less than 20 micro au) before results was generated via the monitor.

Calcium and phosphorus in experimental diet was examined using Atomic absorption spectrophotometer fully automated flame and graphite furnace system (Model AAS – 4000). To ensure precision, 100 g of feed

sample was passed through the collection chamber and the machine was maintained at a temperature range of 3000 ℃, detection limit (Cd<0.04ng/ml) and sensitivity (50ng/ml absorption >0.40 Abs) while the monochromator was placed at wavelength accuracy, resolution, reproducibility (0.15nm, 0.2nm and <0.05nm), blazed wavelength (250nm), focus (300 nm) and wavelength range (185nm – 1000nm).

Statistical analysis

Data obtained on growth performance and egg quality were analyzed by one-way analysis of variance using SPSS statistical software (Version 22.0 for Windows, SPSS, Inc., Chicago, IL, USA). Differences between treatment means were separated using Duncan's test. Significant differences were declared at $p<0.05$.

Results and Discussion

Feedstuffs/Items	Inclusion (%)
Yellow Corn	53.90
Wheat offal	10.00
Soya bean meal	22.00
Fish meal	2.00
Limestone	8.00
Bone meal	3.00
Lysine	0.25
Methionine	0.25
Vitamin-Mineral Premix	0.25
Salt	0.35
Total	100.00
Nutrient levels (% dry matter)	
Crude protein	17.60
Crude fibre	6.92
Ether extract	4.87
Calcium	3.62
Phosphorus	0.45
Lysine	0.89
Methionine	0.48
Metabolizable energy (kcal/kg)	2600.2

Mineral-vitamin premix, Each 2.5 kg sachets contains; Thiamine, 8000 mg, riboflavin, 12,000 mg, pyridoxine, 5000 mg, cyanocobalamine, 5000 mg, niacin, 20,000 mg, D-panthotenate, 10,000 mg, folic acid, 500 mg, biotin, 2000 mg, cholecalciferol, 3,000,000 iu., tocopherol acetate, 25,000 iu., ascorbic acid, 62,000 mg, manganese, 56mg, iron, 70,200 mg, 300 mg, iodine, 200 mg, selenium, 85 mg, choline chloride, 46,000 mg

Table 1: Composition and Nutrient levels of basal diet (%)

Result (Table 2) phytochemical composition of date palm seed powder revealed that phenolic compounds are the most prominent with 891.44 mg/g followed by flavonoids (572.09 mg/g), terpenoids (332.8 mg/g), alkaloids (165.2 mg/g), saponins (90.51 mg/g), steroids (78.66 mg/g) and tannins (65.56 mg/g). These compounds possess numerous therapeutic properties and can be found in several parts of herbal plants (seeds, leaves, roots, stem bark, flowers, buds, amongst others) in different concentrations (Singh et al., 2022; Shittu et al., 2022). Result obtained in this study is in agreement with the reports of Salomón-Torres et al. (2019); Shina et al. (2013). Phenolic compounds have the ability to scavenge free radicals and also inhibit the activities of pathogenic organisms in the gastro intestinal tract of animals (Moslemi et al., 2022; Juhaimi et al., 2012). Flavonoids have been suggested to have cardio-protective, anti-inflammatory, antioxidant, antimicrobial, antiviral and immune stimulatory properties (Musa et al., 2022; Alagbe, 2023). Terpenoids are known to have antimicrobial, hepto-protective, anti-carcinogenic and hypolipidemic functions (Ojediran et al., 2024; Adewale et al., 2021). Tannins exhibits anti-bacterial, anti-mutagenic, anti-allergic and cytotoxic affects (Alagbe, 2023; John, 2024). Alkaloid is reported to have anti-diabetic, hypoglycemic (El Fouhil et al., 2013), analgesic (John, 2024) and antimicrobial activities (Attia et al., 2021). Saponins and steroids are well known to have gastro-protective (Moslemi et al., 2022), anti-diarrhea and immune stimulator (Olujimi, 2024). Saponins are very useful in pharmaceuticals for the treatment of cough and respiratory disorders (Devendran and Balasubramanian, 2011; Wadood et al., 2013).

Constituents	Composition (mg/g)
Phenols	891.44
Flavonoids	572.09
Tannins	65.56
Alkaloids	165.2
Terpenoids	332.8
Saponins	90.51
Steroids	78.66

Table 2: Phytochemicals composition of date palm seed powder

Result (Table 3) effect of date palm seed powder on the growth performance of Lohmann brown hens. Average daily body weight, average daily feed consumption and feed conversion ratio were affected ($p<0.05$) by the dietary supplementation of date palm seed powder. Increasing date palm seed powder across the treatments increased the average daily weight gain and feed consumption compared to the control

(treatment 1; basal diet without date palm seed powder). Average feed consumption and weight gain among hens in treatment 2 (basal diet + 20 g date palm seed powder per kg diet) and 3 (basal diet + 40 g date palm

seed powder per kg diet) were similar (p>0.05) to those which received treatment 4 (basal diet + 60 g date palm seed powder per kg diet) and treatment 5 (basal diet + 80 g date palm seed powder per kg diet) but significantly higher than treatment 1. Conversely, increased supplementation of date palm seed powder decreased (p<0.05) feed conversion ratio. Average body weight gain values which varied from 432.6 - 637.4 g was similar to the results of a study by Olujimi (2024) when Cordyline fruiticosa leaf meal supplemented in the diet of laying hens. This result was higher than those presented by Nobakht, and Moghaddam (2012) when Costmary (Tanacetum balsamita) medicinal plant was fed to layers. The variation in weight gain could be attributed to active stimulation of endogenous enzymes in the gastro intestinal tract by phytochemicals in date palm seed powder (Shittu et al., 2021). John (2024) also reported that inclusion levels of phytogenics in animal feed as well as composition of phyto-constituents in test ingredient could influence the weight gain of birds. Average daily feed consumption recorded in this experiment (117 - 123 g) was in line with a study carried out by Nobakht, and Moghaddam (2010) who discovered that average daily feed intake of laying hens fed phytogenics ranged from 110 - 122 g. Though birds that received date palm seed powder consumed more fed compared to the control, this result suggests that supplementation of date palm seed powder could increase the appetite of laying hens. Feed conversion ratio values which ranged from 4.69 to 5.05 were similar to the results of a study by Mutayoba et al. (2003) who examined the effect of feeding different levels of leucaena leaf meal. Outcome of this experiment showed that laying hens fed diet supplemented with date palm seed powder efficiently utilized their fed to produce eggs (John, 2024). No mortality was recorded throughout the experiments suggesting efficient management practices and thorough biosecurity.

Variables	1[1]	2[2]	3[3]	4[4]	5[5]	SEM
Average initial body weight (g)	1562	1561	1562	1560	1563	54.88
Average final body weight (g)	1994.6[b]	2009.1[a]	2117.8[a]	2119.6[a]	2200.4[a]	69.05
Average body weight gain (g)	432.6[b]	448.1[a]	555.8[a]	559.6[a]	637.4[a]	22.76
Average daily weight gain (g)	5.150[b]	5.334[a]	6.616[a]	6.661[a]	7.588[a]	0.40
Total feed consumption (g)	97180[b]	10200[a]	10248[a]	10332[a]	10332[a]	102.4
Average daily feed consumption (g)	117[b]	122[a]	122[a]	123[a]	123[a]	0.06
Feed conversion ratio	5.05[a]	5.02[a]	4.84[c]	4.87[c]	4.69[c]	0.01
Mortality (percentage)	-	-	-	-	-	-

Means within a row with different letters are significantly different (P < 0.05); [1]basal diet without date palm seed powder; [2]basal diet with 20 g date palm seed powder per kg diet; [3]basal diet with 40 g date palm seed powder per kg diet; [4]basal diet with 60 g date palm seed powder per kg diet; [5]basal diet with 80 g date palm seed powder per kg diet

Table 3: effect of date palm seed powder on the growth performance of Lohmann brown hens

Effect of date palm seed powder on egg production of Lohmann brown hens (Table 4). Hen day house production and hen housed egg production were influenced (p<0.05) by the dietary supplementation of date palm seed powder. Increasing date palm seed powder in the diet increased hen day house production and hen housed egg production. The hen day house production and hen housed egg production in the control group (treatment 1) was 65.12 % and 62.01 % which increased to 79.84 % and 76.11 % respectively in treatment 5. The higher hen day house production and hen housed egg production recorded among hens fed diet supplemented with date palm seed powder suggests that the feed consumed is sufficient to meet all the nutritional needs for the birds for growth, maintenance and production (Sandra, 2022). The presence of essential minerals and amino acid in date palm seed powder could also promote better egg production in hens (Niazi et al., 2017; Juhaimi et al., 2012). Jacob et al. (2014) reported that there are positive correlation between feed conversion ratio and egg production. So, increase of dietary supplementation of date palm seed powder might lead to increase in egg production and improved feed conversion ratio. The result on hen day house production and hen housed egg production in this current research is in line with the findings of Abaza (2007) who reported similar results on response to various levels of fenugreek and chamomile in diets in laying hens. In contrast, Kwari et al. (2011) and Olabode and Okelola (2014) observed a non-significant results in egg production when laying hens were fed diet containing different levels of fenugreek seeds.

Egg production (%)	1[1]	2[2]	3[3]	4[4]	5[5]	SEM
Hen day house production	65.12[b]	71.28[a]	75.63[a]	78.62[a]	79.84[a]	0.15
Hen housed egg production	62.01[b]	69.44[a]	72.91[a]	75.69[a]	76.11[a]	0.13

Means within a row with different letters are significantly different (P < 0.05); [1]basal diet without date palm seed powder; [2]basal diet with 20 g date palm seed powder per kg diet; [3]basal diet with 40 g date palm seed powder per kg diet; [4]basal diet with 60 g date palm seed powder per kg diet; [5]basal diet with 80 g date palm seed powder per kg diet

Table 4: effect of date palm seed powder on egg production of Lohmann brown hens

Effect of date palm seed powder on egg quality of Lohmann brown hens presented in Table 5 revealed that egg weight values varied from 47.12 - 57.03 g, egg width (35.04 - 43.87 mm), egg length (38.81 - 47.88 mm), shell weight (4.11 - 6.34 g), average shell thickness (0.19 - 0.41 mm), albumen height (5.12 - 7.34 mm), yolk length (32.37 - 44.11 mm), yolk height (10.02 - 15.88 mm), yolk weight (14.73 - 20.95 g) were influenced (p<0.05). Result from hens that received treatment 2, treatment 3 were similar (p>0.05) to those in treatment 4 and treatment 5 but significantly higher (p<0.05) than treatment 1 (control).Increasing the dietary supplementation of date palm seed powder lead to a considerably increase in all parameters examined. Improvement of egg weight, egg width and egg length in the present study was also agreed with the findings observed by Ahmad et al. (2016) when botanical extracts and oils were

supplemented in the diet of laying hens. Results obtained suggests that date palm seed powder contains methionine and lysine which can influence the egg weight and length (Uma, 2000). Shell weight and shell

thickness recorded in this present study was within the recommendation range by Gerzilov et al. (2015). This result indicates that date palm seed powder is loaded in calcium, phosphorus, potassium amongst others (Habib and Ibrahim, 2009). John (2024) reported that calcium levels in poultry diets have positive correlation with egg shell thickness. Outcome on yolk length, yolk height, yolk weight and yolk colour is in consonance with the reports of Denli et al. (2004) when black seed extract was supplemented in the diet of laying quails. Yolk colour increased among birds fed date palm seed powder possibly due to the presence of carotene in the sample (Tafti et al., 2017). Haugh unit values in this study which ranged from 69.92 - 83.66 was within the values reported by Yalçın et al. (2012) when yeast autolysate (*Saccharomyces cerevisiae*) and black cumin seed (*Nigella sativa* L.) were supplemented in the diets of laying hens. The haugh unit observed in this experiment was higher than the minimum 72 % suggested by USDA (2000). The higher the value of the Haugh unit, the better the quality of eggs, which are classified according to the United States Department of Agriculture (USDA) as AA (100 to 72), A (71 to 60), B (59 to 30) and C (below 29) (USDA, 2000)

Variables	1^1	2^2	3^3	4^4	5^5	SEM
Egg weight (g)	47.12^b	53.80^a	54.83^a	56.17^a	57.03^a	0.17
Egg width (mm)	35.04^b	41.62^a	42.34^a	43.05^a	43.87^a	0.15
Egg length (mm)	38.81^b	46.33^a	46.72^a	47.23^a	47.88^a	0.14
Shell weight (g)	4.11^c	5.93^b	6.03^a	6.18^a	6.34^a	0.01
Average shell thickness (mm)	0.19^c	0.23^b	0.28^b	0.35^a	0.41^a	0.001
Albumen height (mm)	5.12^c	6.75^b	6.88^b	7.12^a	7.34^a	0.01
Yolk length (mm)	32.37^b	38.02^b	42.16^a	43.50^a	44.11^a	0.13
Yolk height (mm)	10.02^c	12.36^b	13.95^b	15.60^a	15.88^a	0.01
Yolk weight (g)	14.73^c	18.26^b	18.53^b	20.82^a	20.95^a	0.02
Yolk colour	3.13^c	6.93^b	7.02^b	10.56^a	11.23^a	0.17
Haugh unit	69.92^c	73.62^b	75.86^b	81.27^a	83.66^a	0.06

Means within a row with different letters are significantly different ($P < 0.05$); [1]basal diet without date palm seed powder; [2]basal diet with 20 g date palm seed powder per kg diet; [3]basal diet with 40 g date palm seed powder per kg diet; [4]basal diet with 60 g date palm seed powder per kg diet; [5]basal diet with 80 g date palm seed powder per kg diet

Table 5: effect of date palm seed powder on egg quality of Lohmann brown hens

Conclusion

In conclusion, date palm seed powder can be used to boost production due to the presence of phyto-constituents, these compounds has numerous medicinal or therapeutic properties and are not associated with any negative effects in birds. Supplementing date palm seed powder in the diet of laying hens up to 80 g per kg diet is capable of improving their growth performance and quality of eggs. Date palm seed powder can further be used to promote livestock sustainability and food safety.

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