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Effects of rice gluten meal inclusion on productive and economic performance in broilers

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A B S T R A C T

We show valid non-traditional feedstuffs in broiler diets. Arbor Acres plus unsexed one-day old broiler chicks (n = 250) were used to study the effect of rice gluten meal (RGM) on growth performance, carcass characteristics, some serum biochemical parameters and economic efficiency as an alternative to soybean meal and corn gluten meal. They were randomly assigned to five treatments with five replicates per treatment (fifty chicks/ treatment; ten chicks/replicate). The experimental chicks were fed with isoenergetic and isonitrogenous diets supplemented with 0 (control), 3, 6, 9 and 12% RGM for 6 weeks. Growth performance parameters were monitored weekly. Five broilers from each treatment were slaughtered on day 42, for measuring the weight percentages of carcass dressing and internal organs. At 42 days of age, blood samples were collected and serum was separated for determination of serum lipid profile, glucose, total protein, albumin, and globulin. Results showed that broilers fed RGM (up to 12%) had the same performance parameters like the control diet and there was no significant alter among the different groups. RGM had no effect on dressing percentage and internal organs among treatments. Also, no significant change in the serum glucose, total cholesterol, triglycerides, HDL, LDL, total protein, albumin, globulin, ALT, AST, creatinine, uric acid and urea in dietary groups fed on diets contained RGM. The total returns (TR) and net profit revealed no significant (P>0.05) variation was recorded between the dietary groups. In conclusion, broilers fed the RGM diets compared well with those fed the control for growth performance, carcass dressing and blood metabolites and can be included in the broiler diet up to 12% without any deleterious impacts.

Keywords: Rice gluten meal; Broiler; Performance; Carcass; Blood; Economic

1. Introduction

Although the broiler industry in Egypt was quickly escalated over the last decade, providing their nutritional needs is becoming an uneasy task. This is primarily due to scarcity and high cost of feed or feed ingredients. For example, the quantity of maize available for poultry and animal feed has been decreased in the last years due to elevated the use of maize for ethanol production (Kreutzer, 2012). As well, supplying the protein needs of broilers represents a very substantial portion of the feeding cost. In order to compensate for this gap, alternative unconventional feed ingredients must be detected (Abd El-Hack et al., 2019).

New ingredients should have the capacity to partially or completely substitute plant proteins like corn gluten and soybean, and at the same time not have a negative effect on the broilers' efficiency; i.e., it mustn't decrease dressing percentage or, feed efficiency and must manufacture a product of the same or superior quality (Ojewola et al., 2006).

A possible alternative is a rice and rice by-products as a rice gluten meal (RGM). Rice and rice byproducts have become a feed option to replace corn and corn by-products in the feed industry (Honda et al., 2011; Sittiya et al., 2011).

RGM is the dried remains post eliminate of starch by the process employed in the wet milling produce of glucose or syrup or rice starch (Metwally and Farahat, 2015). Replacing corn with feed rice has been demonstrated to have no side effects for poultry, particularly on feed intake, growth performance and feed conversion (Asyifah et al., 2012; Metwally and Farahat, 2015). Although, the high nutritive value of the RGM, the feeding trials on its feeding to poultry are scarce. Based on feed cost, RGM could be an effective alternative unconventional feed ingredient in the broiler's diet. If formulated diets using RGM, producers will be capable to pay less for their diet, hence lowering their overhead cost (Metwally and Farahat, 2015).

Moreover, many trials needs to be carried to determine the optimum inclusion percent of RGM in broiler diets. The objectives of this trial were to determine the growth, carcass characteristics, some blood parameters, and economic efficiency of broilers fed diets involving different grades of RGM as a substitute for soybean meal and corn gluten meal.

2. Material and methods

2.1.Animals and Experimental Design

This trial was conducted at the Poultry Research Farm, Faculty of Veterinary Medicine, Zagazig University, Egypt. Unsexed one-day-old Arbor Acres plus chicks (n= 250), weighing 49±1 g, were selected from a local hatchery. The broilers were randomly divided into 5 experimental treatments with 5 replicates/treatment (50 chicks/ treatment; 10 chicks/replicate). Experimental treatments supplemented with RGM in diets at rate 0 (control treatment), 3 (treatment 2), 6 (treatment 3), 9 (treatment 4), and 12 % (treatment 5) for 42 days. They were vaccinated against Gamboro and Newcastle diseases. Broilers were kept in separate pens under suitable temperature and proper lighting program for six weeks feeding. The isocaloric and isonitrogenous diets were prepared to fulfill nutrient needs of the Arbor Acres plus (2009) and were given in mash form. Briefly, the diet in starter period (0-10 days) contains 23% CP and 3005 kcal/kg diet ME, in grower period (11-24 days) contains 21% CP and 3100 kcal/kg diet ME and in finisher period (25-42 days) contains 19.50% CP and 3200 kcal/kg diet ME as shown in Table 1. Broilers were received water and diet ad-libitum. Diets were examined for DM, CP, and EE (AOAC, 2002).

2.2.Growth Performance Parameters

The individual chicks were weighed at the beginning and after 6 weeks feeding to obtain live body weight (LBW). In the same trend, body weight gain (BWG) was calculated as the final minus initial body weights. The average feed intake (FI) was recorded as the reduction, in grams, of feed. Feed conversion ratio (FCR) were calculated and adjusted for mortalities (Wegner, 1992).

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Table 1: Ingredient composition (%) of the experimental diets used in the starter, grower, and finisher stages

Ingredients	cost/ kg (LE)[2]	Starter diets					Grower diets					Finisher diets				
		Control	3% RGM	6% RGM	9% RGM	12% RGM	Control	3% RGM	6% RGM	9% RGM	12% RGM	Control	3% RGM	6% RGM	9% RGM	12 % RGM
yellow corn	4.00	50.2	50.2	49.8	52.5	55.1	53.8	53.1	53.4	56.1	58.8	59	58.6	58.2	60.9	63.5
Soybean meal, 44%	7.05	35.6	35.7	36.0	31.2	26.4	32.5	32.9	32.0	27.2	22.4	26	26.2	26.4	21.6	16.8
Corn gluten meal, 60%	12.9	6.00	3.00	---	---	---	5.30	2.30	---	---	---	6.00	3.00	---	---	---
Soybean oil	14	3.15	3.30	3.50	2.50	1.60	4.00	4.40	4.40	3.40	2.40	4.50	4.80	5.10	4.10	3.20
Rice gluten meal (RGM), 60%[3]	17	---	3.00	6.00	9.00	12.0	---	3.00	6.00	9.00	12.0	---	3.00	6.00	9.00	12.0
Calcium carbonate	0.3	1.20	1.00	1.00	1.04	1.00	0.91	0.81	0.81	0.81	0.81	1.20	1.20	1.20	1.20	1.20
Calcium dibasic phosphate	11	2.20	2.20	2.20	2.20	2.25	1.90	2.00	2.00	2.05	2.05	1.75	1.75	1.75	1.80	1.80
Common salt	1	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Sodium bicarbonate	10	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Premix[1]	55	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine, Hcl, 78%	34	0.35	0.32	0.30	0.39	0.50	0.30	0.27	0.27	0.37	0.48	0.30	0.27	0.25	0.35	0.46
DL-Methionine, 98%	65	0.30	0.25	0.21	0.16	0.10	0.25	0.21	0.17	0.11	0.06	0.23	0.18	0.16	0.10	0.05
L-Threonine, 98.50%	35	0.10	0.10	0.10	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.06	0.06	0.06
Choline chloride, 60%	22	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08
Antimycotoxin[4]	90	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Anticoccidial[4]	100	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calculated composition																
ME, Kcal/Kg		3005.03	3007	3002	3000.4	3005.4	3103	3108	3109	3107	3106.1	3200	3202	3205	3203	3208.
CP, %		23.08	23	23.	23.	23.	21.54	21.6	21.6	21.6	21.6	19.58	19.6	19.5	19.5	19.5
EE, %		5.32	5.49	5.69	4.86	4.12	6.25	6.63	6.67	5.84	5.01	6.89	7.19	7.48	6.65	5.92
CF, %		3.70	3.7170	3.70	3.47	3.24	3.55	3.56	3.50	3.27	3.04	3.23	3.22	3.22	2.99	2.79
Ca, %		1.13	1.06	1.07	1.07	1.06	0.94	0.93	0.93	0.94	0.93	0.99	1.00	1.00	1.01	1.00
Available phosphorus, %		0.48	0.48	0.48	0.48	0.48	0.43	0.44	0.44	0.44	0.44	0.39	0.39	0.39	0.39	0.39
Lysine, %		1.45	1.44	1.44	1.44	1.44	1.32	1.32	1.32	1.32	1.32	1.16	1.16	1.16	1.16	1.16
Methionine, %		0.69	0.68	0.68	0.68	0.68	0.62	0.62	0.62	0.62	0.62	0.58	0.58	0.58	0.58	0.58
Threonine, %		0.97	0.97	0.97	0.95	0.94	0.90	0.90	0.89	0.88	0.86	0.80	0.79	0.79	0.77	0.76

[1] Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU), vit. D3 (2, 000000 IU), vit. E (10 g), vit.k3 (1000 mg), vit. B1 (1000 mg), vit. B2 (5 g), vit.B6 (1.5 g), pantothenic acid (10 g), vit. B12 (10 mg), niacin (30 g), folic acid (1000 mg), biotin (50 g), fe (30 g), Mn (60 g), Cu (4 g), I (300 mg), Co (100 mg), Se (100 mg) and Zn (50 g).
[2] Ingredients price in Egypt (May, 2019).
[3] Composition for RGM (CP, 58.30 %; EE, 3 %; CF, 1.5%; lysine, 1.57%; methionine, 2.65%;threonine, 1.4%; calcium, 0.23% and ME, 3300 Kcal/kg).
[4] Antimycotoxin and anticoccidial are purchased from Kenavet, Zagazig, Sharkia, Egypt.

Table 2: Overall performance of broiler chickens fed diets contained rice gluten meal (means ±SE)

Trait studied	Experimental diets				
	Rice gluten meal				
	Control	3 %	6 %	9 %	12 %
Initial body weight (g)	49.23±0.44	49.87±0.64	49.77±0.77	49.80±0.47	49.87±0.57
Final body weight (g)	2422.67±14.11	2437.33±14.62	2440.67±13.74	2443.00±13.65	2446±14.00
Absolute BW gain (g)	2373.43±13.97	2387.47±14.38	2390.90±13.23	2393.20±13.18	2396.13±13.76
Total feed consumption (g)	3980.17±49.59	3987.50±46.42	4025.32±37.43	4030.74±38.90	4030.10±39.75
Feed conversion ratio	1.68±0.03	1.67±0.03	1.68±0.03	1.68±0.02	1.68±0.02

Table 3: Carcass traits relative to the live weight of broiler chickens fed diets contained rice gluten meal (means ±SE)

Parameters	Experimental diets				
	Rice gluten meal				
	Control	3 %	6 %	9 %	12 %
Live BW, g	2218.67±109.29	2250±50	2266.67±44.1	2183.33±36.67	2166.67±88.19
Dressing, %	73.55±2.06	74.94±1.28	73.44±0.44	72.95±0.28	72.51±0.97
Intestine, %	4.66±0.78	4.58±0.37	4.96±0.5	4.20±0.13	4.47±0.37
Gizzard, %	1.76±0.05	1.80±0.05	1.76±0.08	1.66±0.01	1.70±0.10
Proventiculus, %	0.32±0.03	0.34±0.01	0.32±0.03	0.28±0.01	0.30±0.03
Liver, %	1.98±0.06	1.96±0.03	1.95±0.05	1.89±0.01	1.85±0.03
Heart, %	0.41±0.03	0.42±0.01	0.43±0.01	0.42±0.01	0.43±0.01
Lung, %	0.53±0.02	0.54±0.04	0.47±0.04	0.58±0.03	0.59±0.14
Spleen, %	0.08±0.01	0.09±0.01	0.08±0.01	0.07±0.01	0.08±0.01
Crop, %	0.29±0.05	0.31±0.03	0.35±0.01	0.34±0.02	0.34±0.01
Kidney, %	0.33±0.04	0.37±0.04	0.40±0.05	0.41±0.10	0.42±0.09

Table 4: Some serum biochemical parameters of broiler chickens fed diets contained rice gluten meal (means ±SE)

Parameters	Experimental diets				
	Rice gluten meal				
	Control	3 %	6 %	9 %	12 %
Glucose (mg/dl)	258.17 ±68.77	241.73±47.84	290.57±18.87	284.23±22.67	282.62±78.66
Total cholesterol (mg/dl)	224.50±33.06	251.47±13.07	235.97±8.20	256.27±17.03	228.77±6.54
Triglyceride (mg/dl)	114.03±12.83	129.85±3.99	103.74±3.24	126.93±11.86	111.58±16.67
HDL (mg/dl)	51.66±3.72	49.86±1.86	51.09±0.80	51.22±0.61	53.30±0.67
LDL (mg/dl)	150.24±34.87	175.64±13.02	164.13±7.37	179.66±15.87	153.14±10.30
Total protein (g/dl)	3.07±0.36	3.31±0.27	3.47±0.32	3.14±0.34	2.67±0.30
Albumin (g/dl)	1.62±0.08	1.89±0.12	2.07±0.12	1.73±0.05	1.53±0.06
Globulin (g/dl)	1.45±0.27	1.42±0.30	1.40±0.21	1.41±0.36	1.14±0.22
ALT (U/l)	11.34±1.89	15.62±2.50	17.75±4.61	14.81±4.43	16.35±2.82
AST (U/l)	331.86±39.89	261.10±45.95	354.03±35.40	263.80±31.57	184.97±27.35
Creatinine (mg/dl)	0.41±0.03	0.33±0.03	0.40±0.08	0.39±0.04	0.38±0.09
Uric acid (mg/dl)	4.34±0.59	6.41±0.57	5.03±0.20	4.22±0.56	4.02±0.91
Urea (mg/dl)	8.01±1.78	8.02±0.91	7.95±1.05	8.45±1.15	10.88±0.81

Table 5: Economic efficiency of broiler chickens fed diets contained rice gluten meal (means ±SE).

Parameters	Experimental diets				
	Rice gluten meal				
	Control	3 %	6 %	9 %	12 %
TVC	25.64±0.32^{d}	26.13±0.30^{cd}	26.91±0.25^{bc}	27.50±0.26^{ab}	28.14±0.27^{a}
TC	42.54±0.32^{d}	43.13±0.30^{cd}	43.91±0.25^{bc}	44.50±0.26^{ab}	45.14±0.27^{a}
Return	64.65±0.37	65.04±0.38	65.13±0.36	65.18±0.36	65.26±0.36
Net profit	22.12±0.68	21.91±0.67	21.22±0.53	20.68±0.52	20.13±0.55

2.3. Carcass Traits

After 42 days from the feeding, 5 broilers/ treatment were randomly chosen, fasted overnight, weighed then slaughtered by a sharp knife to complete bleeding. The dressing percentage, in which the head, neck, feet and lower wing were removed, was estimated by final weighting following plucking of the feather, evisceration. The liver, heart, stomach, intestine, and spleen were also weighed and expressed as percent of LBW.

2.4. Biochemical Analysis

Blood samples from five broilers per group were collected after slaughtering in sterile glass tubes without anticoagulant and placed at room temperature in a slant position for 20 min followed by centrifugation for 10 minutes at 3000 rpm. The serum was then removed and stored at -20 °C until used for further biochemical investigation using various diagnostic kits (Roch Diagnostics, GmbH, USA). Total protein and albumin (Burtis et al., 2006), while globulin was calculated by difference. Alanine aminotransferase (ALT) was assessed according to the method described by Young (2001). Serum aspartate-aminotransferase (AST) was measured (Murray, 1984). Blood creatinine, urea nitrogen, and uric acid were determined (Fossati, 1980). Glucose (Tietz, 2006), total cholesterol (Pisani et al., 1995), triglyceride (Stein and Myers, 1995), HDL-cholesterol (Nitschke and Tall, 2005) and LDL-cholesterol (Sonntag and Scholer, 2001) were measured.

2.5. Economic Efficiency Measurements

The cost parameters were categorized into total variable costs (TVC), and total costs (TC) (Ahmed, 2007; Sara, 2007). On the other hand, returns parameters including total returns (TR) from chick sale equals kg price (26 LE in May, 2019) x bodyweight and net profit (total returns minus total costs) were calculated.

2.6. Statistical Analysis

Data was analyzed by using computerized SPSS (version 25; IBM Corp., Armonk, NY) statistical software package; LSD (Least significance difference) test was used to separate significance means (Snedecor and Cochran, 1982). Alternations among group means were compared using Duncan's multiple range tests (Duncan, 1995). The report of statistical significance was taken as $P < 0.05$. Analysis of variance revealed that the difference between replicates was not significant.

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3. Results and Discussion

The influence of diets contained RGM on overall performance of broiler chickens during the whole experimental period is illustrated in Table (2). Statistical analysis of the data showed that experimental diets contained RGM had no significant ($P<0.05$) change in final BW and total average BW gain and total FI or total FCR during the whole experimental period if compared to control one.

The effect of diets contained RGM on carcass quality traits of broiler chickens is shown in Table (3). There was no significant ($P<0.05$) alter in weight percentages of dressing, intestine, gizzard, proventriculus, liver, heart, lung, spleen, crop and kidney relative to live body weight were detected among dietary treatments fed on diets contained RGM as compared to control one.

The effect of diets contained rice gluten meal on some serum biochemical parameters of broiler chickens is become cleared in Table (4). The obtained results revealed no significantly ($P<0.05$) differed in the serum glucose, total cholesterol, triglycerides, HDL, LDL, total protein, albumin, globulin, ALT, AST, creatinine, uric acid and urea among different treatments in dietary groups fed on diets contained rice gluten meal if compared with the control one.

The effect of diets contained rice gluten meal on economic efficiency of broiler chickens is illustrated in Table (5). There was significant ($P<0.05$) increase in the total variable costs (TVC) and total costs (TC) were recorded in group 5 fed on diets containing 12% rice gluten meal compared with control one. While no significant ($P<0.05$) alter were detected between the other dietary groups. Our results revealed no significantly ($P<0.05$) differed in the total returns (TR) and net profit was recorded among the other dietary treatments if compared with the control one.

The nutritive value of RGM is comparable or even higher than that of corn gluten meal, especially in the AA profile. While many producers think strictly on corn, soybean meal and corn gluten when feeding broilers, they need to realize that broilers require AAs, energy, vitamins, and minerals, rather than any particular feedstuff for normal. Therefore, RGM can be considered a potential alternative ingredient to balance the AA profile of the broiler diet with least cost (Metwally and Farahat, 2015).

Broilers' productivity can be estimated by determining BWG, FI, FCR and dressing %, etc. These parameters are mainly affected by the diet's physical and chemical compositions, so, when a new ration is being estimated, they have to focus heavily on these final points. The statistical results revealed that RGM can be included in broiler diets at a level of up to12% without negative effects on BW, BWG, FI, and FCR at grower and finisher rearing stages as well as cumulative period. Indeed, some isolated spots with statistically significant ($P>0.05$) elevate in BW and BWG at starter stage.

The previous observations reported that growth indices and feed conversion responses weren't affected by feeding RGM even at the highest (12.5%) inclusion level (Metwally and Farahat, 2015). Moreover, corn gluten meal incorporation in broiler diets at low amounts (up to 6%) has no effect on the growth performance (Seyedi and Hosseinkhani, 2014). Similarly, corn gluten meal can be included in broiler diets at a rate of 10% without impairing growth performance (Waldroup, 2000). Also, a study conducted an experiment to study the effect of replacing fish meal in broiler diet with RGM without balancing the amino acid profile and concluded that RGM can be included in the broiler diets at levels up to 10% without negative effect on the FCR (Sherazi et al., 1995).

On the other hand, a significant increase in FI when broiler chicks were fed a diet containing 10% corn gluten meal (Rose et al., 2003) due to imbalance in the amino acids profile (Harper, 1964) or reduce the consumption of lysine (Ping et al., 1972) which in turn, making some signals in brain, that induces a reduction in the feed intake with poor growth performance.

In the current study, balancing the amino acid profile was considered during the formulation of experimental diets. As discussed before, the amino acid composition of RGM is comparable or higher than that of corn gluten meal especially in some of the essential amino acids (lysine, methionine, isoleucine, arginine, and valine). This is why further increase in RGM in broiler diets with balancing of amino acid profile didn't appear any negative impacts on broiler growth performance parameters.

The obtained result showed that feeding of the RGM had no influence on carcass dressing and relative organ weights were detected among dietary treatments. Adding rice gluten meal up to 10% didn't influence the dressing percentage (Sherazi et al., 1995). To date, no trials have been finding in the literature on the influences of feeding RGM on non-profit carcass components. Regarding corn gluten meal, adding corn gluten meal to broiler diets has an adverse effect on carcass traits (Ismail et al., 2005). This could be attributed to the amino acid imbalance, reduction of lysine consumption, reduction of protein consumption and/or imbalanced ratio of energy to amino acids. On the other hand, higher amount of corn gluten meal in the broiler diets (i.e. 12%) can improve breast weight and numerically reduce abdominal fat of the birds (Seyedi and Hosseinkhani, 2014). Additionally, an increase in the carcass fat and dressing percentage due to inclusion of various levels of corn gluten meal in broiler diets (Rose et al., 2003).

Serum biochemical parameters are indicators for the pathological, physiological and nutritional status of the animal and have the ability to use it to illustrate the influence of dietary additives and nutritional factors (Madubuike and Ekenyen, 2006). The all-over results showed that no significantly ($P>0.05$) differed in the serum glucose, total cholesterol, triglycerides, HDL, LDL, total protein, albumin, globulin, ALT, AST, creatinine, uric acid and urea in dietary groups fed on diets contained RGM. The previous observations were supported by Metwally and Farahat (2015) observed that the serum biochemical parameters of broiler chickens at 6 weeks of age didn't differ significantly after feeding graded levels of RGM.

Blood parameters have been observed to be important factors in assessing the response of animals to the diets they are fed (Khan and Zafar, 2005). Serum total lipid, triglyceride, total cholesterol, HDL and LDL didn't alter significantly among dietary treatments (Metwally and Farahat, 2015).

Excess plasma triglycerides (of either dietary or hepatic origin) can lead to fat accumulation in the body (Griffin et al., 1992). Plasma triglycerides are characterized as LDL (Griffin et al., 1982) and the latter is more available for fatty acid synthesis (Griffin and Whitehead, 1982). In broilers, the levels of LDL are correlated to fat deposition in the carcass. Plasma VLDL is a useful parameter to infer the degree of fatness in chickens (Whitehead and Griffin, 1984).

There was no significant alternation between treatments in the serum glucose, total protein, albumin, and globulin of broiler chicks fed graded levels of rice gluten meal. Moreover, the values of serum glucose, total protein, albumin, and globulin are in normal range and compatible with the results of (Obikaonu et al., 2014). Also, it has been observed that levels of serum urea, total protein, and creatinine depend on both the quality and quantity of dietary protein (Iyayi and Tewe, 1998).

Conclusion

Inclusion of rice gluten meal (up to 12%) in broiler diets didn't appear any deleterious impacts on the productive performance, carcass traits and blood parameters as well as economic efficiency through maximizing both

return and net profit. Therefore, it can be used as a partial alternative protein source for soybean meal and corn gluten meal in poultry diets. So, the obtained results suggested that dietary RGM has no deleterious effects on the internal physiology of broiler chickens.

Conflict of Interest

The authors have no conflict of interest to declare.

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