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Effects of quail egg on kidney functions in alloxan induced diabetic Wistar rats

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Abstract

Introduction: Uncontrolled diabetes mellitus has been reported to lead to renal dysfunction. Quail egg consumption has been reported to exert curative effects in some disease conditions like diabetes mellitus, tuberculosis, and asthma. This study investigated the effects of quail egg consumption on some kidney functions in alloxan induced diabetic rats.

Methods: Forty male Wistar rats with an average weight of 170g were randomly divided into four groups. Groups A-Control, B-Diabetic untreated, C-Diabetic treated and D-Normal treated. Groups B and C were made diabetic with a single dose of alloxan monohydrate (100mg/kg i.p). Raw quail egg was administered orally (5ml/kg) to groups C and D for 14days. Body weight and blood glucose were monitored during the study. Blood and kidney samples were obtained from animals in each group, and analyzed for total protein, creatinine, blood urea nitrogen (BUN), renal malondialdehyde (MDA) and superoxide dismutase (SOD). Data were analyzed using ANOVA at $P<0.05$.

Results: Diabetic group treated with quail egg showed significant ($P<0.05$) increase in SOD, decrease in body weight, blood glucose, total protein, creatinine, BUN and MDA levels when compared to diabetic untreated group. However, values of these parameters obtained from diabetic group treated with quail were comparable to control.

Conclusion: Quail egg consumption significantly reduced hyperglycemia, serum total protein, creatinine, BUN, MDA and increased SOD activities in alloxan induced diabetic Wistar rats which suggests that it lowers blood glucose and ameliorates renal impairment in diabetes mellitus.

Keywords: *Diabetes mellitus, Quail eggs, Total protein, Creatinine, Blood urea nitrogen.*

Résumé

Contexte: Le diabète de mellite non contrôlé a été signalé à conduire au dysfonctionnement rénale. La consommation de l'œuf de caille a été rapportée d'exercer des effets thérapeutiques, dans certains états pathologiques tels que le diabète de mellite, la tuberculose et l'asthme. Cette étude a examiné les effets de la consommation des œufs de la caille sur certaines fonctions rénales dans des rats diabétiques induits avec alloxane.

Méthodes: Quarante rats Wistar mâles d'un poids moyen de 170 g ont été répartis au hasard en quatre groupes. Groupes A-Control, B-diabétique non traité, C-diabétique traité et D- Normal traité. Les groupes B et C ont été rendus diabétiques par une dose unique d'alloxane mono-hydraté (100 mg / kg i.p.). L'œuf frais de la caille a été administré par voie orale (5 ml / kg) aux groupes C et D pendant 14 jours. Le poids corporel et la glycémie ont été suivis tout au cours de l'étude. Des échantillons de sang et de reins ont été obtenus à partir des animaux dans chaque groupe, et analysées pour la protéine totale, la créatinine, en nitrogène d'urée sanguine (BUN), malon-dialdéhyde rénale (MDA) et le dismutase super oxyde (SOD). Les données ont été analysées en utilisant ANOVA à $p<0,05$.

Résultats: Le groupe diabétique traité avec l'œuf de la caille a montré une augmentation significative ($P<0,05$) en SOD, diminution dans les niveaux de poids corporel, glycémie, protéines totales, créatinine, BUN et MDA par rapport au groupe non traité diabétique. Cependant, les valeurs de paramètres obtenus à partir du groupe diabétique traité avec de la caille sont comparables au control.

Conclusion: La consommation des œufs de la caille a considérablement réduit l'hyperglycémie, le sérum protéine totale, la créatinine, BUN, MDA et augmentation des activités de la SOD dans les rats Wistar diabétiques induits avec alloxane se qui suggère qu'il abaisse la glycémie et améliore la déficience rénale dans le diabète de mellite.

Mots-clés: *diabète de mellite, œufs de caille, protéine totale, créatinine, urée en nitrogène sanguine.*

Introduction

Diabetes mellitus is a metabolic disorder characterized by hyperglycaemia. It may be due to diminished insulin secretion and/or insulin resistance at the tissue level. This results into disturbance of carbohydrate, lipid and protein metabolism [1]. The pathology of diabetes mellitus includes severe metabolic imbalances and non-physiological changes in many tissues, in which oxidative stress plays a vital role [2].

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Hyperglycaemia, as observed in diabetes mellitus, is known to cause deleterious effects on kidney, liver, eyes and blood vessels due to generation of free radicals which have been implicated in oxidative damage [2]. Oxidative stress has been attributed to direct damage of cellular proteins, lipids and DNA or indirect disruption of normal cell signaling and gene regulation [3].

Till date, no satisfactory effective therapy is available to cure diabetes mellitus and its complications but most patients depend on insulin for management of type 1 diabetes [4]. Without insulin, diabetic patients develop degenerative complications such as microangiopathy, nephropathy and retinopathy [4]. Diabetic nephropathy is the most common cause of death in type 1 diabetes and about 30–40% of affected populations eventually develop end stage renal failure [4].

Quail egg has been reported as a food supplement which contains high nutritional contents of amino acids, antioxidants, fatty acids, vitamins and minerals [5]. These nutritional contents are higher in quail egg than eggs produced by other avians [5]. Among the Chinese, quail egg is used in the treatment of diseases like tuberculosis, asthma, and diabetes [5]. It has been suggested that the glucose regulatory amino acids present in quail egg may be responsible for its ameliorative effects in diabetes mellitus [5, 6].

Therefore, this study investigated the effects of raw quail egg on blood glucose, serum total protein, creatinine, blood urea nitrogen levels, renal malondialdehyde and renal superoxide dismutase in alloxan-induced diabetic male Wistar rats.

Materials and methods

Animals and experimental design

Forty adult male Wistar rats with average weight of 170 g were used in this study. This study was carried out in accordance with Institutional Guidelines of the Ethical Review Board of the University of Ibadan. The rats were fed with rat pellet diet (Vital feed, Jos, Nigeria) and allowed free access to water *ad libitum*. Quail eggs were obtained from the Department of Agriculture, University of Ibadan, Oyo state, Nigeria. They were cleaned under running water and broken gently to get the content (yolk and albumen). This was whisked and administered immediately at a dose of 5 ml/kg body weight.

Animal grouping

The rats were divided into four groups of ten animals each. Group A serves as the normal control; group B, diabetic untreated; group C, diabetic treated with quail egg and D, normal rats treated with quail egg. Groups C and D were fasted for 18 hours before inducing diabetes with a single intraperitoneal injection of alloxan monohydrate (100 mg/kg) [7, 8]. Blood glucose level was measured 72 hours after alloxan injection and animals with sustained blood glucose level above 200 mg/dl [9] were grouped as diabetic.

Blood sample collection

Blood glucose level on days 0, 3, 4, 8. 11 and 15 was assessed from each rat by the tail tipping method. Samples obtained were collected on an Accu-check glucose test strip prior to analysis on the Accu-check glucometer [10]. The principle of glucose oxidase method formed the basis of analysis by the glucometer. On days 8 and 15, 3 to 4mls of blood samples were collected from each animal per group through the retro-orbital sinus into clean specimen bottles and were allowed to clot. Thereafter, the samples were centrifuged at 3000 rpm for 15 mins at room temperature to obtain clear serum which was used for biochemical analysis.

Composition of phosphate buffer

Di-potassium hydrogen orthophosphate (0.496g), K_2HPO_4 and 0.973 g of potassium di-hydrogen orthophosphate were dissolved in 100 ml of distilled water at a pH of 7.4

Kidney sample collection

Kidney samples were obtained from each animal after euthanasia by cervical dislocation. They were weighed and homogenized in cold phosphate buffer using ratio 1:4. The kidney homogenate was centrifuged at 7000 rpm for 15 minutes at room temperature. The supernatant collected was used for biochemical assay.

Biochemical assay

Estimation of serum total protein, creatinine and BUN were done by colorimetric method, using Randox assay kit (Randox Laboratories limited, UK). Renal SOD was assessed as described by Mistra and Fridovich [11] while renal MDA was estimated as described by Buege and Aust [12].

Statistical analysis

Data were expressed as mean ± S.E.M, analyzed using ANOVA followed by Dunnet's test for significance. Statistical significance was set at ($P<0.05$).

Results

The total body weight (g) of diabetic untreated rats (142.8 ± 2.7) and diabetic treated rats (127.2 ± 12.1)

showed significant (P<0.05) reduction when compared with control (203.6 ± 16.2) (Table 1).

The blood glucose level (g/dl) in diabetic untreated rats (542.6 ± 141.2) showed significant

Table 1: Effect of quail egg on body weight (g) in control, diabetic and diabetic treated rats.

Days	A	B	C	D
0	156.20±6.50	169.80±8.20	162.20±3.20	162.01±2.90
4	171.41±5.80	164.00±5.70	152.00±5.00	163.40±8.80
8	166.01±4.30	142.00±7.30	136.60±9.90	177.21±0.70
15	203.61±6.20	142.80±2.70*	127.21±2.10*	173.01±2.10

Values are mean ±*SEM* (n=5). *P<0.05*. *significantly different from control. A= Control rats. B= Diabetic untreated rats. C= Diabetic rats treated with quail egg. D= Normal rats treated with quail egg.

Table 2: Effect of quail egg on mean kidney weight (g) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	0.47± 0.02	0.47±0.01
B	0.58± 0.03*	0.64±0.03*#
C	0.59±0.03*	0.54±0.04
D	0.49±0.02	0.51±0.04

*Values are mean ±SEM (n =5). P< 0.05. *significantly different from control. #significantly different from control and normal-treated. A = Control rats. B = Diabetic untreated rats. C = Diabetic rats treated with quail egg. D = Normal rats treated with quail egg.*

Table 3: Effect of quail egg on Mean Total Protein (g/dl) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	6.84±0.32	7.60±0.11
B	8.56±0.10*,#	8.64±0.07*,#
C	7.86±0.24	7.24±0.14
D	7.46±0.19	7.54±0.57

*Values are mean ±SEM (n=5). P <0.05, *significantly different from control and normal-treated. #significantly different from diabetic treated. A = Control rats, B = Diabetic untreated rats. C = Diabetic rats treated with quail egg. D = Normal rats treated with quail egg.*

There was significant (P<0.05) increase in kidney weight (g) in diabetic untreated rats (0.58 ± 0.03, 0.64 ± 0.03) and diabetic treated (0.59 ± 0.03, 0.54 ± 0.04) on days 8 and 15 respectively when compared with control (0.47 ± 0.02, 0.47 ± 0.01) (Table 2).

(p<0.05) increase compared with diabetic treated rats (174.8 ± 27.71) and control (79.2 ± 9.1) (Figure 1). There was significant (P<0.05) increase in serum total protein level (g/dl) in the diabetic untreated rats (8.56 ± 0.10, 8.64 ± 0.07) on days 8 and 15 respectively

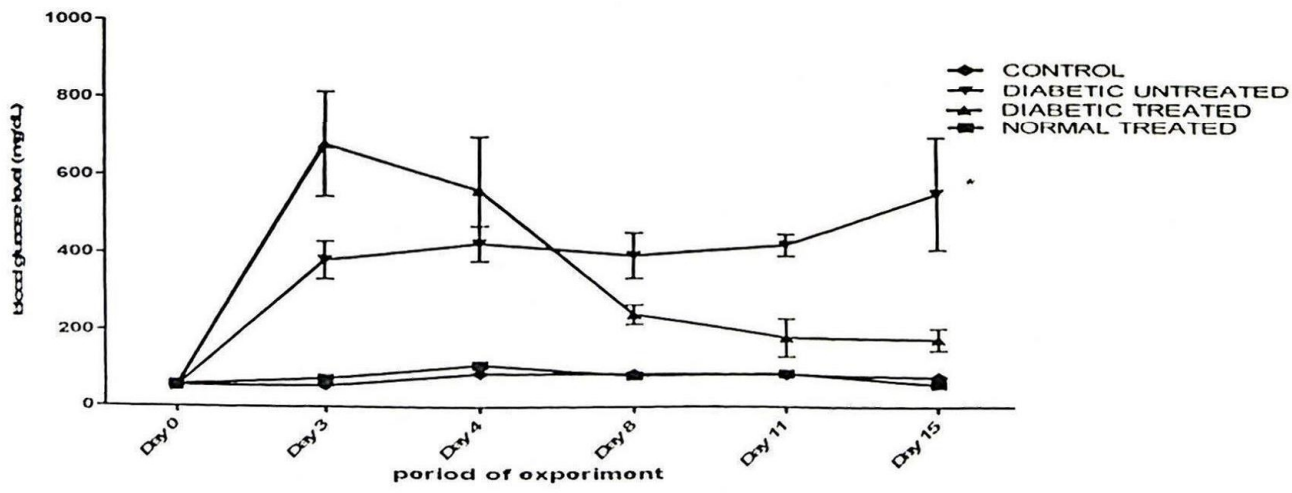

Fig. 1: Effect of quail egg on fasting blood glucose (mg/dl) in treated and untreated diabetic rats. Values are mean ± *SEM* (n=5). *P 0.05*.* significantly different from control

compared to control (6.84 ± 0.32, 7.60 ± 0.11). However, serum total protein level in diabetic treated (7.86 ± 0.24, 7.24 ± 0.14) were comparable to control (6.84 ± 0.32, 7.60 ± 0.11) on days 8 and 15 respectively (Table 3).

Table 4: Effect of quail egg on serum creatinine (mg/dl) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	0.50±0.04	0.72±0.05
B	1.18±0.06*	1.16±0.05*
C	0.60±0.03	0.72±0.04
D	0.50±0.03	0.84±0.09

*Values are mean ±SEM (n=5), P < 0.05, *significantly different from control. A= Control rats, B= Diabetic untreated rats, C= Diabetic rats treated with quail egg, D= Normal rats treated with quail egg.*

There was significant (P<0.05) increase in the serum creatinine level (mg/dl) in diabetic untreated rats (1.18 ± 0.06, 1.16 ± 0.05) when compared to diabetic treated rats (0.60 ± 0.03, 0.72 ± 0.04) and control (0.50 ± 0.04, 0.72 ± 0.05) on days 8 and 15 respectively (Table 4).

Table 5: Effect of quail egg on Blood Urea Nitrogen (mg/dl) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	14.20±0.58	15.60±0.25
B	18.00±0.00*	18.40±0.25*
C	15.00±0.45	15.00±0.32
D	14.20±0.20	16.20±0.37

*Values are mean ±SEM (n=5), P<0.05, *significantly increased from control, diabetic-treated and normal-treated. A= Control rats, B= Diabetic untreated rats, C= Diabetic rats treated with quail egg, D= Normal rats treated with quail egg.*

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There was significant (P<0.05) increase in renal malondialdehyde level (nmol/g) in diabetic untreated rats (0.772 ±0.173, 0.751 0.079) on days 8 and 15. However, renal malondialdehyde level in diabetic treated rats (0.381±0.086, 0.097±0.007) were comparable to control (0.259±0.021, 0.150±0.070) on days 8 and 15 respectively (Table 6).

Table 6: Effect of quail egg on renal MDA (µmol/g) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	0.26±0.02	0.15±0.07
B	0.77±0.17*	0.75±0.08*
C	0.38±0.09	0.10±0.01
D	0.35±0.05	0.20±0.05

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There was significant (P<0.05) decrease in renal superoxide dismutase activities (unit/ml enzyme) in diabetic untreated rats (67.29±8.41, 29.60±15.92) when compared with diabetic treated rats (227.80± 39.93) and control (226.60±19.86) on days 8 and 15 respectively (Table 7).

Table 7: Effect of quail egg on renal superoxide dismutase (unit/ml Enzyme) in control, diabetic and diabetic treated rats.

Groups	Day 8	Day 15
A	212.50±12.77	226.60±19.86
B	67.29±8.41*	29.60±15.92*
C	151.50±7.83	227.80±39.93
D	160.90±12.36	244.20±43.77

*Values are mean ±SEM (n=5), P < 0.05, *significantly decreased from control, diabetic-treated and normal-treated. A= Control rats, B= Diabetic untreated rats, C= Diabetic rats treated with quail egg, D= Normal rats treated with quail egg.*

Discussion

Diet and physical activity are important in the management of diabetes mellitus [13]. The consumption of appropriate diet during the use of medication and controlled physical activities have been reported to greatly improve blood glucose level and decrease the risk of diabetes complications such as renal disease and coronary artery disease [13].

However, diabetes mellitus has been associated with a decline in body weight [14] which has been attributed to an increase in muscle wastage and protein metabolism [9, 15]. This study is consistent with the report of Akinola *et al.*, [14] who also reported reduction in body weight in the diabetic untreated rats. Treatment of diabetic animals with quail egg did not lead to increased weight gain as observed in normal rats treated with quail egg. However, Saiki *et al.*, [16] reported that an appropriate diet with a reduction in body weight

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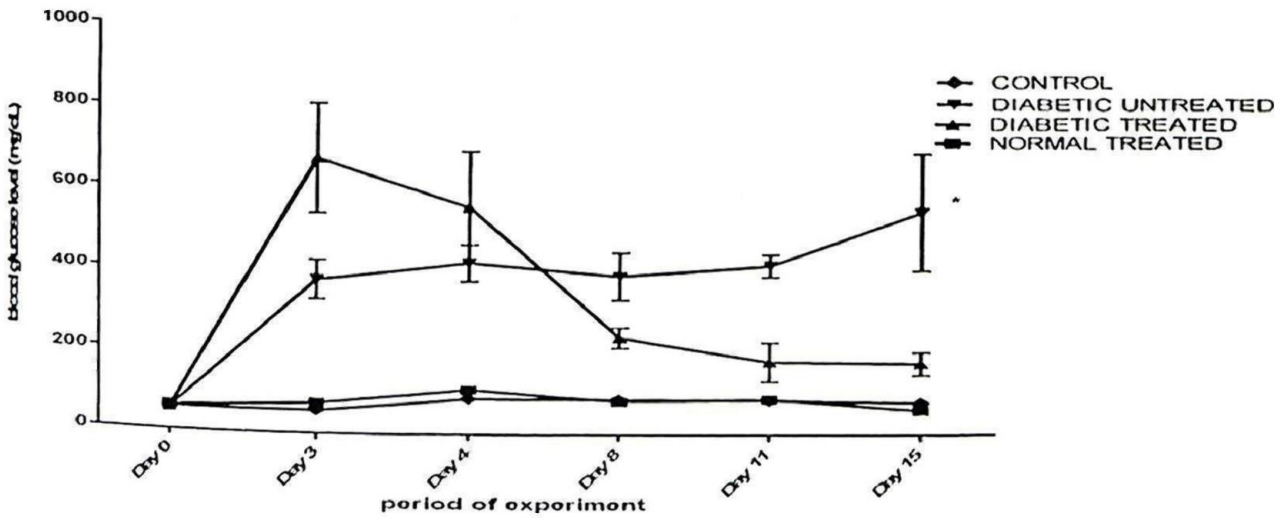

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decreases proteinuria and improves kidney function. This study also showed that consumption of quail egg lowered the plasma glucose in alloxan induced diabetic rats which may be due to the presence of some glucose regulatory amino acids in quail egg. These include leucine, lysine, valine and alanine [5]. This suggests that an appropriate diet, rich in glucose regulatory amino acids may decrease blood glucose level.

The United States Renal Data System has reported enlargement of the kidney in diabetes mellitus [17]. However, this study showed that quail egg consumption reduced the enlargement of the kidney as observed in diabetic treated rat. It is likely that quail egg consumption might have prevented inflammation of kidney tissues thereby preventing the enlargement of the kidney tissues as reported by the United States Renal Data System [17].

Renal dysfunction in diabetes mellitus has been reported to lead to proteinuria, elevated serum creatinine and urea levels [18, 19]. The observed significant elevation in serum total protein, creatinine and BUN levels in the diabetic untreated rats is consistent with the report of Seyed-Mostafa *et al.*, [20]. Therefore a reduction in proteinuria is important in the management of renal dysfunction [21]. This study showed reduced serum total protein, creatinine and BUN levels as observed in diabetic rats treated with quail egg which suggests attenuation of renal dysfunction [2, 7]. Elevated serum total protein observed in the diabetic untreated group may be due to increased dehydration and inflammatory processes as observed in poorly controlled diabetes mellitus [22].

In addition to the renal dysfunction observed in untreated diabetes mellitus, there was also an increase in the production of free radicals within the renal tissues. These free radicals exert cytotoxic effect on the membrane phospholipids resulting in lipid peroxidation of renal tissues and renal damage [23]. Renal antioxidants therefore constitute an important defense mechanism against the deleterious effects of free radicals within the kidneys. In this study, a depletion of renal antioxidant and elevation of lipid peroxidation of renal tissue was observed in diabetic untreated rats. Whereas, values obtained in diabetic rats treated with quail egg suggest a potentiation of antioxidant activity which might have mopped up the free radicals and resulted in the observed reduction in renal lipid peroxidation. This observed effect may be due to high content of dietary antioxidants such as vitamin E, zinc and lysine which are present in quail egg [5].

In conclusion, treatment of alloxan induced diabetic Wistar rats with quail egg significantly reduced hyperglycaemia, serum total protein, creatinine, blood urea nitrogen, malondialdehyde and increased superoxide dismutase activities. This suggests that quail egg consumption in diabetes mellitus reduces plasma glucose level and ameliorates renal impairment observed in untreated diabetes mellitus.

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decreases proteinuria and improves kidney function. This study also showed that consumption of quail egg lowered the plasma glucose in alloxan induced diabetic rats which may be due to the presence of some glucose regulatory amino acids in quail egg. These include leucine, lysine, valine and alanine [5]. This suggests that an appropriate diet, rich in glucose regulatory amino acids may decrease blood glucose level.

The United States Renal Data System has reported enlargement of the kidney in diabetes mellitus [17]. However, this study showed that quail egg consumption reduced the enlargement of the kidney as observed in diabetic treated rat. It is likely that quail egg consumption might have prevented inflammation of kidney tissues thereby preventing the enlargement of the kidney tissues as reported by the United States Renal Data System [17].

Renal dysfunction in diabetes mellitus has been reported to lead to proteinuria, elevated serum creatinine and urea levels [18, 19]. The observed significant elevation in serum total protein, creatinine and BUN levels in the diabetic untreated rats is consistent with the report of Seyed-Mostafa *et al.*, [20]. Therefore a reduction in proteinuria is important in the management of renal dysfunction [21]. This study showed reduced serum total protein, creatinine and BUN levels as observed in diabetic rats treated with quail egg which suggests attenuation of renal dysfunction [2, 7]. Elevated serum total protein observed in the diabetic untreated group may be due to increased dehydration and inflammatory processes as observed in poorly controlled diabetes mellitus [22].

In addition to the renal dysfunction observed in untreated diabetes mellitus, there was also an increase in the production of free radicals within the renal tissues. These free radicals exert cytotoxic effect on the membrane phospholipids resulting in lipid peroxidation of renal tissues and renal damage [23]. Renal antioxidants therefore constitute an important defense mechanism against the deleterious effects of free radicals within the kidneys. In this study, a depletion of renal antioxidant and elevation of lipid peroxidation of renal tissue was observed in diabetic untreated rats. Whereas, values obtained in diabetic rats treated with quail egg suggest a potentiation of antioxidant activity which might have mopped up the free radicals and resulted in the observed reduction in renal lipid peroxidation. This observed effect may be due to high content of dietary antioxidants such as vitamin E, zinc and lysine which are present in quail egg [5].

In conclusion, treatment of alloxan induced diabetic Wistar rats with quail egg significantly reduced hyperglycaemia, serum total protein, creatinine, blood urea nitrogen, malondialdehyde and increased superoxide dismutase activities. This suggests that quail egg consumption in diabetes mellitus reduces plasma glucose level and ameliorates renal impairment observed in untreated diabetes mellitus.

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