CARCASS AND INTERNAL ORGAN CHARACTERISTICS OF BRIOLER CHICKENS FED SOYBEAN DIETS PARTIALY REPLACED WITH VARIABLE LEVELS OF RAW JACKFRUIT SEED MEAL

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Abstract
One hundred and forty-four (144) broiler chickens were used to evaluate the carcass and internal organ characteristics of broiler chickens fed soybean diet partially replaced with variable levels of raw jackfruit seed meal (RJFSM). The study lasted for 7 weeks. The inclusion levels of RJFSM were 10, 20 and 30% respectively. The birds were divided into four dietary treatments and three replicates of twelve birds per replicate in a Completely Randomized Design (CRD). Treatment one (T1) was the soybean based which served as the control, while RJFSM was added to Treatment two (T2), Treatment three (T3) and Treatment four (T4) at 10, 20, 30% respectively. Feed and water were provided to the broiler chickens *ad libitum* while other routine management practices were maintained. Parameter recorded were initial weight, final weight, feed intake, weight gain and feed conversion ratio (FCR), then carcass and internal organ characteristics. There was no significant difference ($P>0.05$) in the weight of liver, heart, spleen and gizzard. Significant differences ($P<0.05$) were observed in crude protein (CP) and ash of the proximate analysis of the experimental diet. The final weight and daily feed intake (DFI) of the birds fed the experimental diets differed significantly ($P<0.05$). Significant, differences ($P<0.05$) were observed in live weight, de-feathered weight, dressed percent, thigh, drumstick, back and breast. Significant differences ($P<0.05$) were observed in small intestine and large intestine lengths. The similarities between the control diet and the RJFSM containing diets in the relative weights of the internal organs shows that the inclusion of the (RJFSM) up to 30% did not reveal any adverse effect in the broiler chickens.

Keywords: Jack Fruit Seed, Broiler chickens, Carcass characteristics and Internal Organ

Introduction

The most promising way to solve the problem of competition between man and animal for plant protein is to identify cheaper and easily available feed stuff that are of low human preference and little or no industrial use that can meet nutritional requirements of poultry with or without processing (Akinmutimi, 2004). One of such seeds that has potential of being used in poultry feed is Jackfruit seed meal (*Artocarpus heteropophyllus*). Jackfruit seed meal is lesser known in nutritional and agronomic researches. It was introduced to Nigeria from India and adapted so well in Nigeria, but not yet fully exploited as animal feed resource. The nutritional value of jack fruit both tender ripe fruit and seed are rich in minerals and vitamins. Ripe fruits are rich in vitamin A, which maintain good vision. The protein content of jackfruit is as high as 22.94% according to Akinmutimi (2006). It was introduced into Nigeria from India which has adapted so well in Nigeria. It is known in South East of Nigeria among the Igbo's as ukwa bekee/ukwa oyibo. It is a delicacy among the people of Idemili, Anambra state and seed is discarded as waste. The discarded seeds in the urban and peri-urban markets, are potential environmental hazard because they attract flies and many do not know its importance. It is grown mainly for its fruits in Anambra, pulp and foliage for their livestock. Being a good source of vitamin A, C and pectin, jackfruit helps in alleviating the pancreatic system ailment and also in blood purification (Ndyomugyenyi *et al*., 2014). Jackfruit is the largest of all cultivated fruits and yield of about 500 fruits per tree annually have been reported. This research which is the preliminary study was aimed at evaluating the use of raw jackfruit seed meal in the diet of broilers with the specific objective of determining the optimum replacement level in the performance of internal organ characteristics of broiler chickens.

Materials and Methods

Experimental Location

The Research work was carried out at the Poultry Unit of the Teaching and Research farm of Michael Okpara University of Agriculture, Umudike located within the tropical rain forest zone and lies between latitude $5^0$29'N and longitude $7^0$32'E and 122m above sea level and the environment is characterized by an annual rainfall ranging from 60-68mm (NRCRI, 2014)

Experimental Diet

The test ingredients *Artocarpus heterophylus* were sourced locally from Ogidi in Idemili North Local Government Area in Anambra State. The seeds were sun dried and milled. The raw Jackfruit seed meal (RJFSM) obtained were then incorporated into the diets of the broiler chickens. The T1 (control diet) was soybean-based and contained 0% RJFSM while treatments 2, 3 and 4 were included RJFSM at 10, 20 and 30% levels respectively. The proximate composition of the raw RJFSM and percent composition of the experimental diet (starter and finisher phase) is presented in Table 1, 2 and 3 respectively.

Table 1: Proximate composition of raw Jackfruit seed (*Artocarpus heterophyllus*) (% DM basis)

Nutrients	Percentage
Dry matter	**89.88**
Crude protein	**27.57**
Ether extract	**3.06**
Crude fiber	**40.30**
Ash	**4.00**
Nitrogen free extract	**50.99**
Cross energy kcal/g	**3.13**

Management of Experimental Birds

One hundred and forty-four (144) day–old chicks were procured from CHI farm in Osun state for the experiment.

Table 2: Percentage Composition of Experimental Broiler Starter Diets

Feedstuffs	T1	T2	T3	T4
Maize	51.50	49.41	47.32	45.23
Soya bean	34.70	33.32	31.94	30.56
RJSM	-	3.47	6.94	10.41
Palm Kernel	10.00	10.00	10.00	10.00
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated composition:				
Crude protein (CP%)	**22**	**22**	**22**	**22**
ME (Kcal/kg	**2,867.5**	**2,872.8**	**2,878.0**	**2,883.3**

The individual weights of the chicks were measured and randomly assigned to four (4) dietary treatments in a Completely Randomized Design (CRD). Each treatment was replicated three times containing twelve (12) birds per replicate and a total of thirty-six (36) birds per treatment. All the necessary medications were administered while feed and water were given *ad libitum.* The temperature of the brooding house was monitored by the reaction of the birds to heat intensity by

observing their behavior as recommended by Oluyemi and Roberts (2000) and Olomu (2003). Other important routine management practices were observed. The brooding period lasted for 7 days while the feeding trial lasted for 6 weeks (42 days).

Table 3: Percentage Composition of Experimental Broiler Finisher Diets

Feedstuffs	**Control (T1)**	**T2**	**T3**	**T4**
Maize	57.22	53.72	51.98	50.24
Soya bean	28.98	26.68	25.53	24.37
RJFM	-	5.80	8.69	11.59
Palm kernel	10 00	10.00	10.00	10.00
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Bone meal	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated composition:				
Crude protein (CP%)	**20**	**20**	**20**	**20**
ME (Kcal/kg)	**2,920.9**	**2,930.0**	**2,934.4**	**2,934.8**

Data Collection

Daily feed intake data was obtained by getting the differences between the quantity of feed offered and the quantity leftover (not consumed). The birds were weighed at the beginning of each experiment and subsequently on a weekly basis. Data on initial weight, final weight, daily weight gain, daily feed intake, and feed conversion ratio (FCR) were obtained. Mortality was recorded when it occurred throughout the period of the experiment. Three broilers per replicate were selected, weighed individually and slaughtered by cutting the neck close to the head with a sharp knife and allowed to bleed completely after starving the bird for 12 hours. Scalding was done in hot water (below 100^0C) and the feathers plucked off manually and individually. Evisceration was with a sharp knife and the entire gut content (organs and intestine) carefully removed and weighed immediately. The heart, liver, empty gizzard and spleen were weighed using an electronic sensitive (Acculab) scale.

Data Analysis

The proximate components of the diets and jackfruit seed meals were determined according to methods of A. O. A. C. (1990). Data collected on body weight, weight gain, feed intake, FCR, carcass and internal organs characteristics were subjected to Analysis of Variance (ANOVA) using procedure of SPSS version 20 (SPSS, 2010). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The proximate composition of the experimental diet at the starter phase and finisher phase is presented in Table 4 and 5 respectively. Significant differences ($P<0.05$) were observed in crude protein (CP) and ash. Generally, the inclusion of RJFSM in the broiler diets increased the crude protein as well as the ash content of the diets. Ndyomugyenyi *et al.*, (2016), reported that raw jack fruit seed meal contained crude protein (15.1%), dry matter (92.5), ether extract (0.98%), crude fiber (4.2%) and ash (3.78%). Compared to their result, the DM was lower whereas, crude protein, ether extract, crude fiber and ash were higher in this study. The CP of the RJFSM diets T2, T3, and T4 are higher ($P<0.05$) than that of the Control diet. Values of 6.34 – 8.57% CP have also been reported for jack fruit seed flour (Mukprasirt and Sajjaanantakul, 2004) as well as 17.8 – 18.3% CP obtained by Kumar *et. al.*, (1988) which is lower than the values obtained in this study.

The ash contents of the RJFSM containing diets are higher than that of the Control diet. The ash content had an increasing trend as the level of the JFSM increased in the diet. The ash value obtained for the raw seeds are higher than that reported earlier 2.90% by (Morton, 1987); 2.76 – 3.31% (Morton, 1987); 4% (Akinmutimi, 2006) and 2.70% reported by Ocloo *et. al.,* (2010). The differences may be attributed to different sources of seeds. Olomu (1995) reported ash content within the range 3.1% for broad bean, 3.4% for kidney bean and 6.4% for soybean which are all lower than the values obtained in this study. The crude fat obtained in this study is higher than the value of 0.88% reported by (Morton, 1987); 2.2% (Singh *et. al.,* 1991) for Jack fruit seeds; 1.3% (Bobbio *et. al.,* 1978) and 2.1 – 2.5% (Kumar *et. al.,* 1988) for Jack fruit seeds. Ocloo *et. al.,* (2010) reported lower fat content, 1.27% compared to the values obtained in this study.

The crude fibre level though it was not significant in this study showed an increasing trend. Akinmutimi (2006) and Ocloo *et. al*., (2010) obtained CF of about 4.03% and 3.19% respectively, in raw a JFS which is far lower than the value obtained in this study. The values obtained from the raw seeds were equally lower than the conventional feed stuffs like soybean meal and groundnut cake with 6.5 and 5% respectively, crude fibre as well as maize and guinea corn with 2.0% crude fibre (Pfizer, 1995). Significant differences ($P<0.05$) were observed in dry matter (DM), moisture, crude protein (CP) and ash content of the dietary treatments. No significant difference ($P>0.05$) was observed in the crude fat and crude fibre content of the diets. Crude fat and crude fibre were similarly not affected significantly as in the starter phase.

The Control diet recorded the highest ($P<0.05$) DM followed by the 20% and 30%JSM diets, while the 10%JSM was least. The dry matter values of the raw JSM diets are very high and are numerically close to the values established for the Control diet. It then follows that JSM can effectively supplement normal corn-soy diets at the highest level evaluated. Crude protein was similarly highest ($P<0.05$) in T_1, T_2 and T_3 but declined significantly ($P<0.05$) in T_4, which contained 30%JSM. Thus, it could be deduced that the 10% and 20% JSM compared with the Control diet in CP. The inclusion of JSM up to 30% depressed the CP. Kumar *et al.* (1988) reported 17.8-18.3 % CP which compares well with the values established in this study. As earlier noted, the CP obtained in this study are higher than those reported by several workers (Mukprasirt and Sajjaanantakul, 2004; Ravindran *et al.,* 1996; Ocloo *et al*, 2010; Tulyathah, 2001).

Percent ash was highest at higher levels of JSM inclusion (20% and 30%) but was reduced at the lower level of inclusion (10%) which incidentally compared with the Control diet statistically. The percent ash obtained in this study are higher than the those obtained by some previous researchers (Morton, 1984; Morton, 1987); Akinmutimi, 2006; Ocloo *et al*, 2010). The difference may be attributed to different sources of seeds. Olomu (1995) reported ash content of 6.4% for soybean which compared well with the values obtained in T_2 (10% RJFSM) in this study.

Table 4: Proximate composition of experimental diet at the starter phase

Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
	0%JSM	**10%JSM**	**20%**	**30%JSM**	
Dry matter	89.80	89.40	89.00	88.80	0.27
Moisture	10.20	10.60	11.00	11.20	0.27
Crude protein	20.20^{b}	22.60^{a}	23.85^{a}	24.10	0.53
Crude fat	4.20	4.10	3.80	3.60	0.25
Crude fiber	13.20	13.80	14.60	15.10	0.33
Ash	6.10	7.20	8.60	10.00	0.51

abc: Means within the same rows with different superscripts differ significantly (p<0.05); SEM- Standard error of the mean.

Table 5: Proximate composition of experimental diet at the finisher phase

Parameter	T_1 0%JSM	T_2 10%JSM	T_3 20%JSM	T_4 30%JSM	SEM
Dry matter	91.40[a]	80.40[C]	89.00[b]	88.80[b]	1.28
Moisture	8.60[b]	10.60[a]	11.00[a]	11.20[a]	0.40
Crude protein	19.60[a]	19.10[a]	18.40[a]	15.00[b]	0.59
Crude fat	5.60	5.00	4.50	4.00	0.30
Crude fibre	8.00	9.20	9.85	10.60	0.34
Ash	5.50[b]	6.00[b]	8.60[a]	8.60[a]	0.50

a-b Means within the same row with different superscripts differ significantly (P<0.05); SEM- Standard error of the means

The growth performance of broiler chickens fed diets containing variable levels of raw Jackfruit seed meal (RJFSM) is shown in Table 6. Significant differences (P<0.05) were observed in final weight and daily feed intake (DFI) of the birds fed the experimental diets. Final weight was significantly highest (P<0.05) in T_1, T_2 and T_3 but least in T_4. Thus, it could be deduced that the 10% and 20% RJFSM diets compared with the Control diet, whereas, the 30%JSM depressed body weight. An attempt to include raw or inadequately treated jackfruit seed meal in chicken diets caused retarded growth of the birds because of anti-nutrients (Ravindran *et al.,* 1996). These researchers however reported improved growth performance at inclusion levels as high as 25% when the seeds were only boiled for 10 minutes. Anti-nutrients in raw JSM such as saponins, alkaloids, phytic acid, and triterpenes (Ndyomugyenyi *at al.*, 2014; Akinmutimi, 2006; Ravindran *et al.,* 1996) could have played a role in depressing growth of the broilers.

Ndyomugyenyi *et al.* (2016) reported higher tannin (11.1 vs. 1.28 g/kg) and higher oxalate (10.0, 1.47 g/kg) in raw Jackfruit seed meal compared to processed ones. Saponins significantly affect growth, and reproduction of animals; they impair digestion of protein and uptake of vitamins and minerals in the gut (Francis *et al.,* 2002). Phytic acid is known to affect protein and lipid utilization (Kumar *et al*, 2010), because it inhibits enzymes such as pepsin, amylases and trypsin, needed to digest food (Coulibaly *et al.,* 2011; Ramakrishna *et al.,* 2006). Oxalate can result in formation insoluble complex of calcium oxalate which affects the gut thereby resulting in low feed intake and its attendant problems (Olomu, 1995). Phytin can form insoluble salts with minerals like calcium and magnesium making them unavailable for metabolic processes. Tannin can form complex linkage with protein leading to loss of protein and its attendant poor growth (Akinmutimi, 2006). Saponin has deleterious effect such as bitter taste, foaming properties and haemolytic effect on red blood cells (Olomu, 1995).

Daily feed intake was most significant in T_3 (20% RJFSM) followed by T_2(10% RJFSM), whereas the 30% RJFSM and the Control diet obtained the least DFI. Thus, 10% and 20% JSM inclusion improved the DFI. The depressed DFI observe at the 30%JSM may be connected with the level of anti-nutritional factors in the RJJFM. Ndyomugyenyi *et al.* (2016) observed that feed intake decreased at higher level. They reported that feed intake was not affected up to 240 g/kg but reduced at 320 g/kg inclusion by 18.3%. According to Tome and Bos (2000), the nutritional value of proteins in feeds may differ considerably as regards to variable factors that include their essential amino acid content. Ndyomugyenyi *et al.* (2016) reported higher tannin (11.1 vs. 1.28 g/kg) and higher oxalate (10.0, 1.47 g/kg) in raw jackfruit seed meal compared to processed ones. Saponin has deleterious effect such as bitter taste, foaming properties and haemolytic effect on red blood cells (Olomu, 1995). It is possible that the 30% RJFSM has higher content of saponin which imparted a bitter taste thus resulting in poor performance.

Table 6: Growth Performance of broiler chickens fed diets containing variable levels of raw Jackfruit seed meal

Parameter	T_1 0%JSM	T_2 10%JSM	T_3 20%JSM	T_4 30%JSM	SEM
Initial weight (g/bird)	211.33	204.33	204.67	231.00	5.26
Final weight (g/bird)	1180.95[a]	1195.24[a]	1185.71[3]	980.95[b]	28.54
Daily weight gain (g/b/d)	23.09	23.59	23.36	17.86	"0.76
Daily feed intake (g/b/d)	82.72[b]	82.00	89.25[a]	82.84[b]	1.00
Feed Conversion Ratio	3.58	3,48	3.82	4.64	0.28
Mortality (%)	0.00	0.00	0.00	0.00	0.00

a-b Means within the same row with different superscripts differ significantly (PO.05); SEM- Standard error of the mean

The zero mortality recorded for all the treatment groups suggests that feeding RJFSM up to the 30% level did not adversely affect the performance of the broiler chickens. Interestingly, the low mortalities of birds at higher levels of RJFSM inclusion suggests that lethal effects of JSM as result of anti-nutrients (Akinmutimi, 2006; Ravindran *et al.,* 1996) were greatly reduced without processing.

The carcass characteristics of broiler chickens fed raw Jackfruit seed meal (RJFSM) is indicated in Table 7. Significant, differences (P<0.05) were observed in live weight, de-feathered weight, dressed percent, thigh, drumstick, back and breast; whereas, no significant difference (P>0.05) was observed in dressed weight and wings. The Control diet recorded the highest (P<0.05) live weight and de-feathered weight, followed by T_3 (20% RJFSM). Dressed percent was highest (P<0.05) in T_4 (30%JSM) followed by T_3 (20%JSM) which compared statistically with the Control diet. Relative thigh weight was highest (P<0.05) in TI and T_2 but least in T_4. Drumstick was similarly highest in T_1, T_2 and T_3 but least in T_4. Back cut was most significant in T_3, whereas values obtained for T_2 and T_4 compared with that of the Control diet. Relative breast weight on the other hand was most significant in T_2 followed by T_3 and least in T_4 which compared with the Control diet. The reduction in live weight, de-feathered weight, thigh and drumstick at the 30% JSM may be connected with the presence of anti-nutritional factors, lower feed intake as well as reduced crude protein of the finisher phase. Ndyomugyenyi *et al.* (2016) attributed the reduced feed intake at higher levels of JSM inclusion as well as poor quality protein of the Jackfruit seed meal to be probably responsible for the growth depression.

According to Adeyemi *et al.* (2008) dressed weight is more important to poultry meat consumers than the live weight because feathers add more to live weight and the dressed weight represents the absolute value of saleable meat. The similarity in dressed weight in this study shows that up to 30% level of the RJFSM can be included in the diet of broiler chickens without having any adverse effect. However, a numerical assessment of the dressed weight shows that the Control diet performed better than the RJFSM-containing diets and that T_3 (20% RJFSM) which recorded 916.66g performed very close to the Control diet which recorded l00g as earlier noted.

The breast meat, drumstick and thigh are the most expensive commercial cuts of the chicken (Adeyemi *et al.,* 2008). According to Agunbiade (2002), thigh, drumstick and breast cut are prime cuts of chicken, which gives a picture of the carcass meatiness and eventually revenue yield. Compared to the other JSM diets, the 10% level (T_2) performed better in terms of thigh weight and breast weight. However, up to 20% level of the RJFSM favoured drumstick.

Table 7: Carcass characteristics of broiler chickens fed raw Jackfruit seed meal (RJFSM)

Parameter	T_1 0%JSM	T_2 10%JSM	T_3 20% JSM	T_4 30%JSM	SEM
Slaughter weight (g)	1766.66[a]	1366.66[b]	1600.00[ab]	1266. 66[b]	72.82
Dressed percent	57.08[b]	54.88[C]	51.29[b]	60.00[a]	0.60
Wings (%)	13.42	13.97	13.80	13.09	0.27
Thigh (%)	17.76[a]	17.74[a]	16.72[ab]	14.93[b]	0.43
Drumstick (%)	18.16[a]	16.98[a]	16.71[a]	14.49[b]	0.47
Back (%)	20.88[b]	20.95[b]	24.36[a]	20.59[b]	0.53
Breast (%)	28.06[C]	38.48[a]	30.30[b]	26.78[C]	1.39

abc Means within the rows with different superscripts differ significantly (PO.05); SEM-Standard error of the mean

The internal organ proportions of broiler chickens fed raw Jackfruit seed meal (RJFSM) is presented in Table 8. Significant differences ($P<0.05$) were observed in small intestine and large intestine lengths. The inclusion of Jackfruit at the different dietary levels did not significantly ($P>0.05$) affect the relative weights of liver, heart, spleen, gizzard, proventriculus, small intestine and large intestine. T_3 (20% RJFSM) recorded the most significant ($P<0.05$) values for small intestine length. The large intestine lengths of T_1, T_2 and T_3 compared statistically and were higher ($P<0.05$) than the value obtained for T_4. The similarities between the Control diet and the RJFSM-containing diets in the relative weights of liver, heart, spleen, gizzard, proventriculus, small intestine and large intestine shows that the inclusion of the JSM up to 30% did not reveal any adverse effect in the broiler chickens (Soma and Santa, 2015).

Ndyomugyenyi *et al* (2016) reported that except for gizzard; weights of liver, heart, intestines and pancreas were affected. On the contrary, weights of liver, heart and intestine were not affected in this study. However, gizzard weight was equally not affected which agrees with the report of these researchers. They equally showed that processing RJFSM increased the relative increment of 12.7% in gizzard weight at 320 g/kg RJFSM inclusion whereas, the relative *gizzard* weight was declined with the raw RJFSM as revealed in this study. Contrasting findings were reported when whole grains were used in poultry diets (Engberg *et al.,* 2004; Gabriel *et al*, 2007; Lu *et* al.,2011; Roche, 1981).

Table 8: Internal organ proportions of broiler chickens fed raw Jackfruit seed meal (RJFSM)

Parameter	T_1 0%JSM	T_2 10%JSM	T_3 20%JSM	T_4 30%JSM	SEM
Liver (%)	1.55	1.62	1.47	1.75	0.25
Heart (%)	1.63	0.43	0.39	0.40	0.29
Spleen (%)	0.12	0.14	0.11	0.08	0.25
Gizzard (%)	2.02	2.31	1.97	2.01	0.25

abc Means within the rows with different superscripts differ significantly (PO.05); SEM-Standard error of the mean

The 20% RJFSM recorded the most significant value for small intestine length. The small intestine is known as the site of food absorption; thus, the higher length of the birds fed the 20%JSM which incidentally performed significantly in final weight may be connected with efficiency of food absorption. The reduction in the length of the large intestine at the 30% JSM might probably be associated with the presence of anti-nutritional factors at this level. Anti-nutrients in RJFSM such as saponins, alkaloids, phytic acid, and triterpenes (Ndyomugyenyi *et al.,* 2014; Akinmutimi 2006; Ravindran *et al.,* 1996) could have played a role in depressing growth of the broilers. Ndyomugyenyi *et al.* (2016) reported higher tannin (11.1 vs. 1.28 g/kg) and higher oxalate (10.0, 1.47 g/kg) in raw jackfruit seed meal compared to processed ones. Soma and Santa (2015) recommended that small to moderate proportion of dry heat treatment to jackfruit seed powder increases its biological value.

Conclusion

This study evaluated the nutritional value of raw Jackfruit seed meal fed to broiler chickens at variable levels. Jackfruit seed meal (RJFSM) has the potential to serve as an alternative feedstuff to most corn-soy based diets. Thus, its inclusion at an optimum level will help to reduce the high cost of maize and soybean. This research recommends the inclusion of 20% raw jackfruit seed meal to broiler chickens diet which improved performance compared to the Control diet and since higher level (30%) depressed performance. Perhaps, if this research were to be done in Nigeria we may have reasons for more comparison and therefore the call for more research here in Nigeria.

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