International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html



# Evaluation of Different Grain Substrates for Spawn Production and Yield Performance of Oyster Mushroom (*Pleurotus florida*)

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**Abstract**

Spawn quality, which is dependent on grain composition, is a critical factor that must be optimized to achieve successful and profitable mushroom farming. In the current study the spawn was developed on different kinds of cereals. The grain substrates were inoculated with mother spawn of *Pleurotus florida* mushroom and incubated for mycelial run including maize, sorghum, wheat grain spawn and their mixture maize: sorghum: wheat grain spawn (1:1:1). Once the spawn was prepared, it was planted into rice straw substrate where they showed variable effect on number of days from cultivation to first flush which ranged from 15-33 days. The sorghum grain substrate showed the highest chemical composition (Nitrogen, Phosphorus, potassium, protein and carbohydrates) in fruit bodies followed by the mixture the wheat and maize in both seasons. This is due to the higher nutritional value of the sorghum and the mix (1:1:1) as compared to other substrates that's in role induce higher, better and healthy mycelial growth that affect the chemical composition of mushroom fruit bodies. Depending on the current results and the previous studies, it is highly recommended to use sorghum grain substrate as a carrier for spawning which can improve the spawn quality and gaining faster and best growth achieving maximum yield that's in role increase or maximize the profit.

**Keywords:** Oyster mushroom, spawn, grain substrate, yield, chemical composition.

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## 1. Introduction

Mushrooms are the fleshy, spore-bearing fruiting body of a fungus belongs to Basidiomycota division. It represents one of the worlds greatest untapped resources of nutritious food. Mushroom provide a rich addition to the diet in the form of proteins, carbohydrates, minerals and vitamins [1]. Furthermore, it contains abundance of essential amino acids and low-fat content. Since mushrooms don't have chlorophyll, they are classified as eukaryotic heterotrophs, meaning they feed on decomposing organic matter [2]. The production of edible, saprophytic mushrooms may be the only practical biotechnology available at the moment for recycling organic waste and lignocelluloses. That integrates the decrease of environmental pollution with the production of food that is high in protein.

Oyster mushroom cultivation is quick to produce profits from, takes little area, is inexpensive, and is straightforward. Three things are necessary for successful mushroom cultivation: high-quality spawn, suitable substrate, and an appropriate environment [3].

The mycelium of mushrooms growing on a certain grain substrate is called mushroom spawn, and it is utilized as a planting media for mushrooms. A significant degree of skill, particular knowledge, and attention are required from individuals participating in the technologically complex process of spawn production [4]. It is regarded as the cornerstone of the global mushroom business and the primary impediment to mushroom growing [5]. The most crucial element in the production of edible mushrooms is spawn quality. In order to reproduce generatively, mushrooms in the wild use spores, which are minuscule and extremely challenging to manage. Alternatively, tissue cultures taken from cap tissues can be used to create spawn. Grain spawn is widely used due to its ease of planting and speedy ramification of the substrate [6]. The first step in mushroom cultivation is the production of good quality spawn and a stable strain which can fulfill the expectation of the growers. The quality spawn may be achieved by selection of a suitable spawn carrier which influences the growth habit of the mycelium and subsequent yield [7]. The search for the best cereals grain for use in spawn production is complicated by factors related to the types of available local grains, as well as their moisture and nutritional contents, including the cultivation [8]. There hasn't been much research conducted in

Egypt on oyster mushroom spawn production. Given these details, the current study's objective was to assess the various grain substrates for oyster mushroom spawn development and yield performance.

## 2. Materials and Methods

A lab experiment was carried out during the period from 2021 to 2022 in Mushroom Research Laboratory (MRL), Department of Horticulture, Faculty of Agriculture, Zagazig University, to study the effect of different spawning grain substrates on the productivity of oyster mushroom.

Strain and maintenance

Oyster mushroom (*Pleurotus florida*), used in this study was obtained from climate national laboratory, National research center, Egypt was. It was cultivated on potato dextrose agar (PDA) slants at 25º C for 7 days, stored at 4º C and sub-cultured at regular intervals of four weeks [7].

Spawning substrates

A number of four different grain crops were used as a medium for mushroom spawn production including maize, sorghum, wheat grain spawn and their mixture maize: sorghum: wheat grain spawn (1:1:1).

### *2.1: Spawn preparation*

All the grain spawn was boiled separately in water for 30 minutes (Half cooked grains) and after the temperature reduced the boiled grains were dried by central centrifuge then mixed with calcium carbonate powder at 2% level, fill the grains in a 1 Kg plastic bags (can be autoclaved), plug with cotton and sterilize in autoclave at 120 C for 20 minutes. At the next day, the spores from pure cultures were used to inoculate the prepared grain spawn. The pure culture (use 15-18 days old spawn for spawning) of the fungus was procured from national climate laboratory, agriculture research center, Egypt. Then it was incubated at room temperature for 15 days [7].

### *2.2: Preparation of rice straw*

Rice straw was chopped into particles (15-20cm) and soaked in tap water for 12 hours, then left to drain the excess water, after that it was pasteurized in life steam system at 80 – 90O C for 6 hours. These pasteurized rice straws were left to reach to room temperature [9,10].

### *2.3: Oyster mushroom cultivation*

After pasteurization the substrates were get out and spread in a 10 cm layer thickness applied in four layers, into polyethylene bags 60 cm depth x 40 cm diameter. Every bag contains 2 kg dry substrate (about 6 kg wet substrate) and the spawn material was distributed over each layer at the rate of 5 % (w/w) (this equal about 150 g spawn per bag).

### *2.4: Mycelial growth*

The inoculated polyethylene bags were transferred to the incubation room at the temperature 25 + 3°C with less ventilation and darkness till full colonization (two weeks). Then the polyethylene bags were pinned and transferred to the production room, where the temperature was 20+3○C, and the relative humidity was maintained to about 80-90% using a foggy system [11].

The polyethylene bags were perforated to have enough aeration needed for fungal growth. The holes were 1cm diameter and were distributed as 5 cm between each other’s (50 holes /bag).

### *2.5: Data recorded*

### *2.5.1: Fresh and dry Yield*

At suitable harvesting stage, all clusters were harvested and the following data were recorded including Total fresh yield of mushroom /bag, Total dry yield / bag [6].

### *2.5.2: Biological efficiency*

It was defined as percentage of the fresh weight of harvested mushroom over the dry weight of substrate as explained by [12]

Number of days from spawning to first flush.

### *2.5.3: Chemical constituents of fruit bodies and substrates Dry matter percentage (D.M. %)*

Samples of 100 gm of fruit bodies from each replicate were dried in an electrical oven at 105ºC till constant weight and DM% was determined [13].

### *2.5.4: Minerals, protein and total carbohydrates*

Samples of 50 gm of fruit bodies from each replicate as well as samples of 200 gm from each used substrate before spawning and after harvesting, were taken, then dried (by using an electrical oven) at 70ºC till constant weight. The dried materials were grinded to a fine powder for the following chemical analysis.

Nitrogen, phosphorus and potassium were determined according to the methods described by [14,15,16], respectively.

### *2.5.5: Crude protein (%)*

It was determined as nitrogen content and multiplied by 4.35 and 6.25 to convert it to equivalent protein content for fruit bodies and substrates, respectively [17].

### *2.5.6: Total carbohydrates (%)*

It was determined following the method described by [16,18].

### *2.6: Statistical Analysis*

The obtained data were subjected to statistical analysis of variance according to [19] and means separation were done according to [20].

## 3. Results

Spawn quality is the most important factor in the production of oyster mushroom. Using different grain substrates for spawn preparation in order to improve the spawn quality and gaining faster growth.

Fungal growth on different grain and its effect on the yield and biological efficiency are shown in Table (2). Four different gain substrates were used as a substrate for spawning including sorghum, maize, wheat and a mixture (1:1:1). For fresh yield per bag (g) the three grain substrates maize, sorghum and the mixture gave high yield while wheat grain substrates showed lower yield in both seasons. For dry matter per bag the sorghum and maize substrates showed the higher dry matter yield per bag than wheat and the mix substrates at the first season. At the second season the mix showed the highest dry matter per bag followed by sorghum then wheat and maize cam at the third rank.

Biological efficiency expressed as a percentage of the fresh weight of harvested mushroom over the dry weight of substrate (Table 2). The maize substrate showed the highest biological efficiency as compared to the other substrates at the first season. At the second season sorghum and the mixture grain substrates were the superior as compared to the other substrates for biological efficiency. The wheat grain substrate showed the highest number of days to first flush while the other grain substrates showed short period than wheat at the first season. At the second season, there was no significant different between all substrates for the number of days to first flush.

**Table 1:** Analysis of grain used as a medium for spawning

| Grain medium | N (%) | P (%) | K (%) | Carbohydrates (%) | Protein (%) |
|---|---|---|---|---|---|
| Sorghum | 2.24 | 0.56 | 2.15 | 72.65 | 14.01 |
| Maiz | 1.56 | 0.40 | 1.74 | 70.21 | 9.76 |
| Wheat | 1.94 | 0.47 | 1.82 | 61.36 | 12.15 |
| Mix | 2.01 | 0.50 | 1.93 | 68.34 | 12.60 |

**Table 2:** yield and biological efficiency components as affected by using different grain substrates for spawning

| Treatments | Fresh matter yield/bag (Mean ± SE) | Dry matter yield/ bag (Mean ± SE) | Biological efficiency (Mean ± SE) | Number of days to first flush (Mean ± SE) |
|---|---|---|---|---|
| First Season | | | | |
| Sorghum | 2536.2±182.40 a | 53.87±43.65 a | 126.81±9.12 b | 15.65±1.70 b |
| Maize | 2925.5±195.83 a | 53.31±33.67 a | 146.28±9.79 a | 19.37±2.49 b |
| Wheat | 1200.2±595.77 b | 46.24±38.24 b | 114.50±8.88 b | 33.97±2.62 a |
| mix | 2308.1±75.55 a | 44.49±56.49 b | 115.41±3.78 b | 14.94±0.82 b |
| Second Season | | | | |
| Sorghum | 2832.3±34.54 a | 43.65±1.43 b | 141.62±1.95 a | 31.00±1.63 a |
| Maiz | 2620.4±49.92 b | 33.67±2.43 c | 131.02±2.76 b | 26.00±8.04 a |
| Wheat | 2089.2±22.61 c | 38.24±2.53 c | 104.46±3.82 b | 32.00±3.27 a |
| mix | 2848.2±49.56 a | 56.49±0.56 a | 142.42±3.37 a | 30.67±2.49 a |

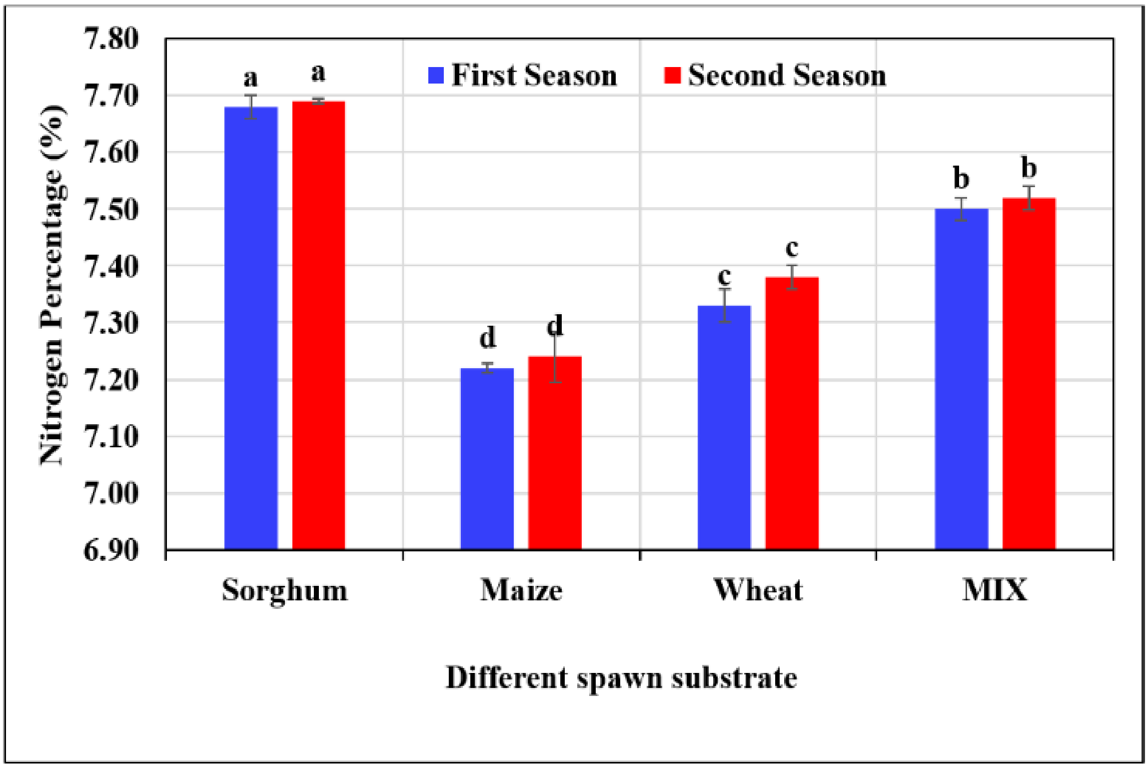


**Figure 1:** Effect of different spawn substrates on nitrogen percentage of oyster mushroom fruit bodies.

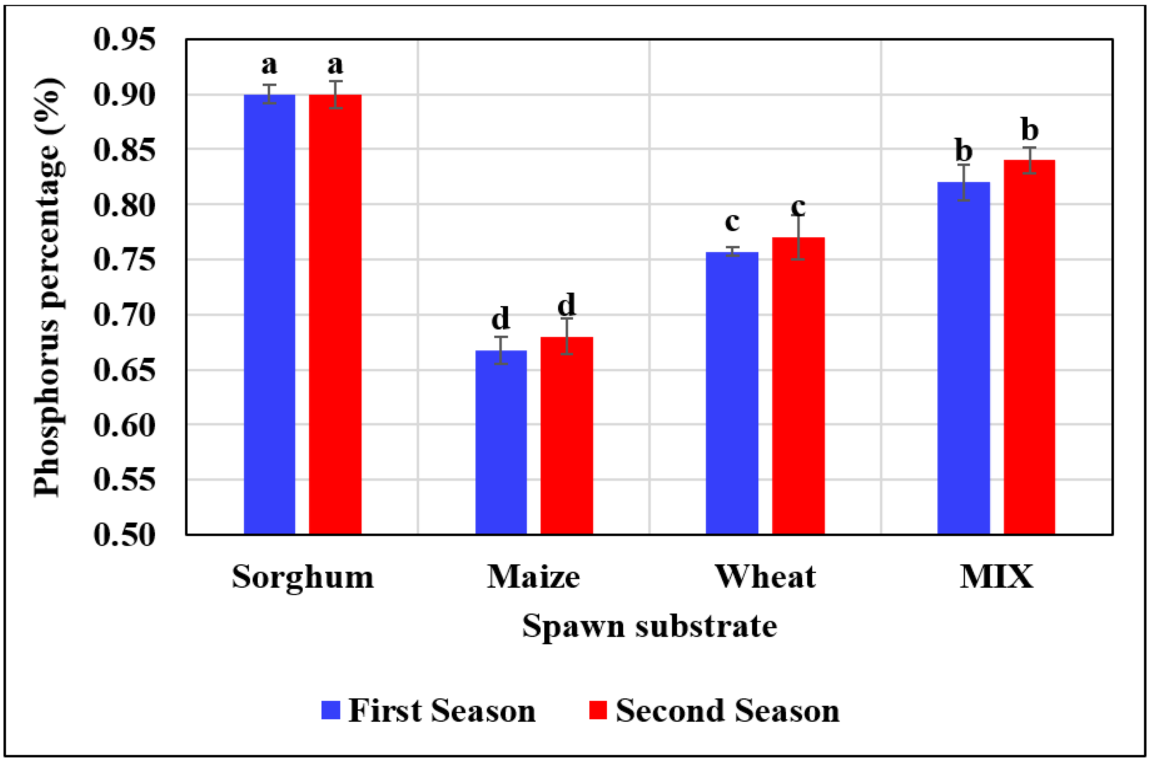


**Figure 2:** Effect of different spawn substrates on phosphorus percentage of oyster mushroom fruit bodies.

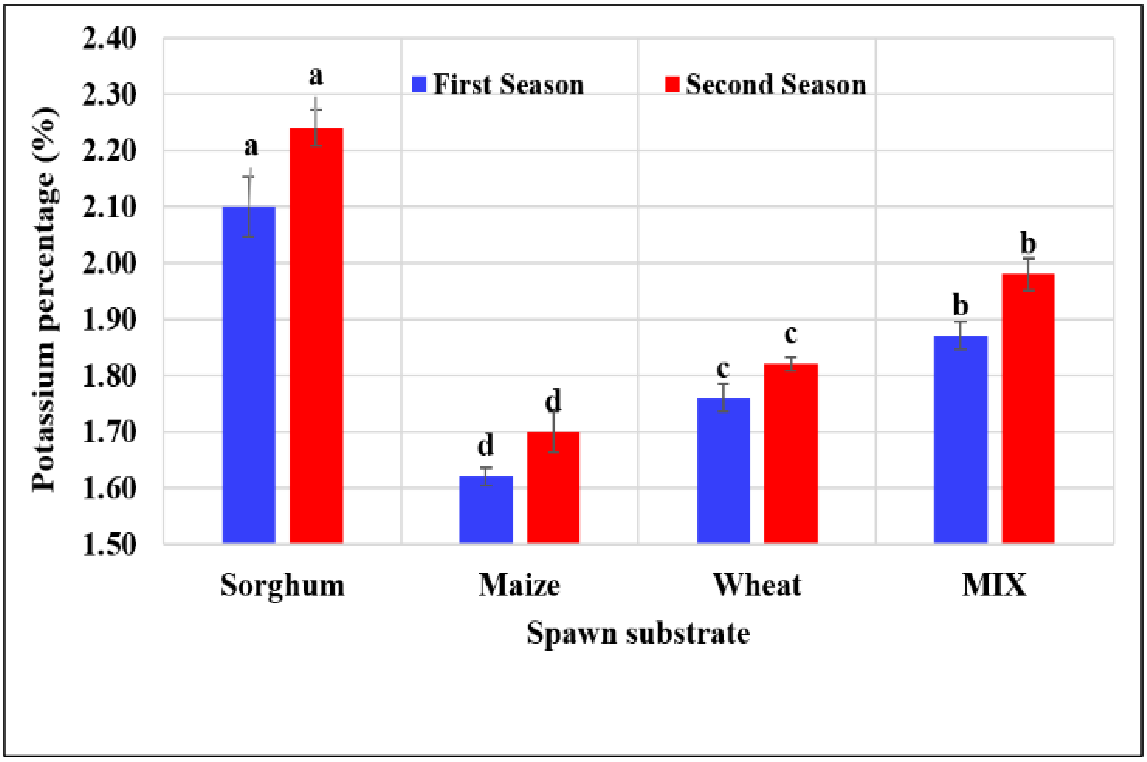


**Figure 3:** Effect of different spawn substrates on potassium percentage of oyster mushroom fruit bodies.

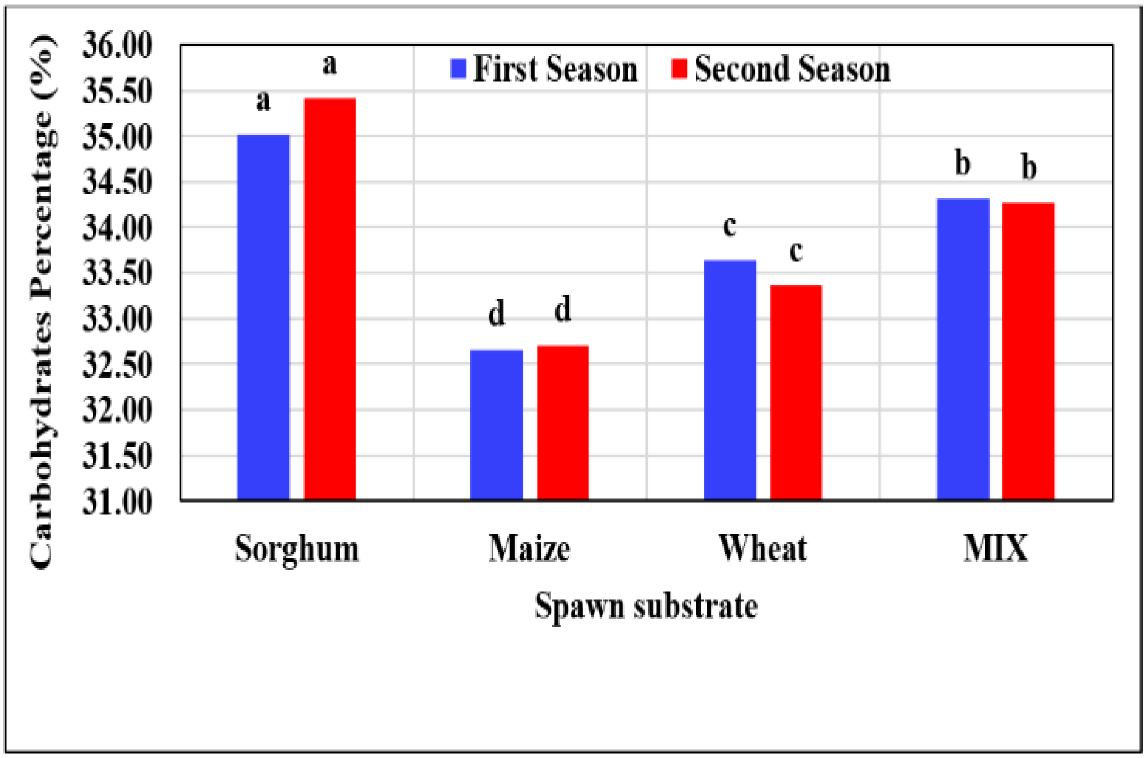


**Figure 4:** Effect of different spawn substrates on carbohydrates percentage of oyster mushroom fruit bodies.

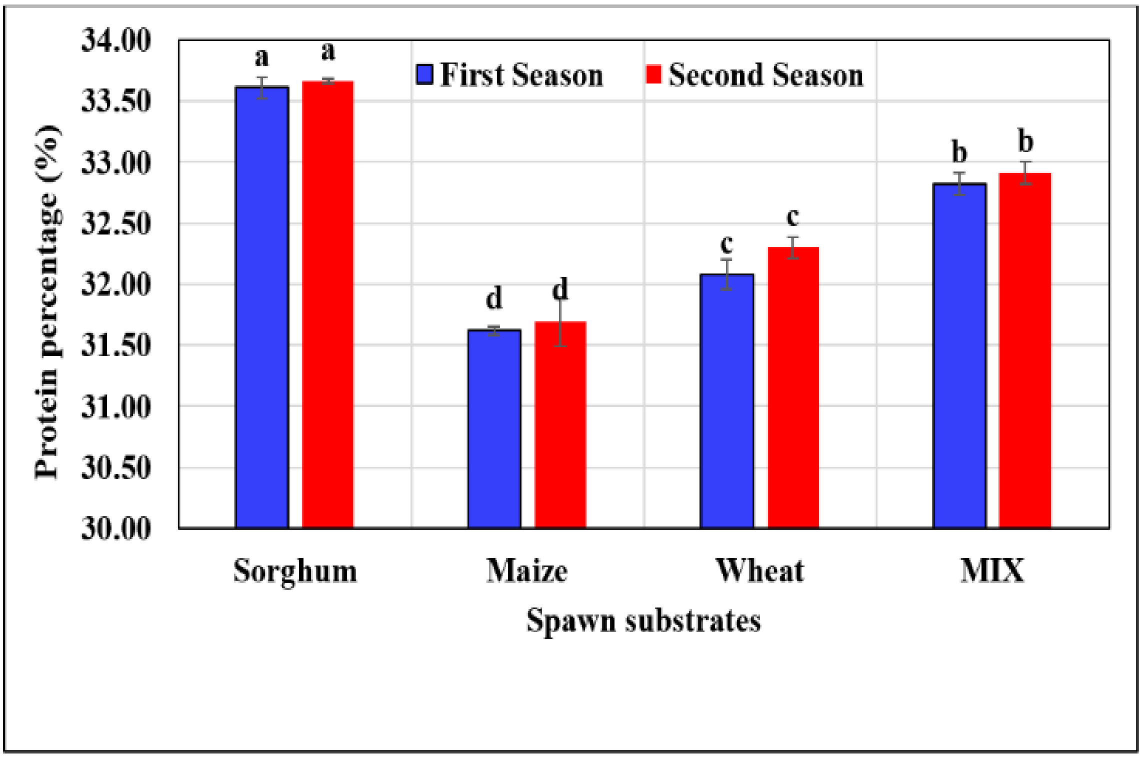


**Figure 5:** Effect of different spawn substrates on protein percentage of oyster mushroom fruit bodies.

The current results using sorghum substrates gave the highest nitrogen contents in the fruit bodies followed by the mixture then wheat and maize grain substrates at both seasons (Figure 1). The nitrogen contents in mushroom fruit bodies showed 7.68 and 7.69 % at the first and second seasons, respectively. The phosphorus contents in mushroom fruit bodies were showed at Figure 2. It was clear from Figure 2 the sorghum grain substrate showed the highest phosphorus contents in the mushroom fruit bodies. The mixture (1:1:1) sorghum: wheat: maize grain substrates gave 0.9 % phosphorus content in mushroom fruit bodies and came in the second rank at both seasons. Followed by wheat and maize which came in the third and fourth rank, respectively. The results of Figure 3 showed the effect of using different grain substrates on potassium contents in mushroom fruit bodies on the base of dry matter. At both seasons the sorghum grain substrate significantly showed the highest potassium content on mushroom fruit bodies with values 2.10 and 2.24 % at the first and second seasons, respectively. The mix substrate came at the second rank with a potassium content 1.87 and 1.98% in mushroom fruit bodies at the first and second seasons, respectively. Wheat and maize grain substrates came at the third and fourth rank. Fruit bodies carbohydrates content as affected by different grain substrates are shown in Figure 4. The current results of fruit bodies carbohydrates content followed the same trend as nitrogen, phosphorus and potassium contents. Figure 4 showed that carbohydrate content at fruit bodies grown on sorghum grain substrate was the highest. Followed by mix, wheat and maize at both seasons. The protein contents showed significant difference in mushroom fruit bodies according to different grain substrates (Figure 5). The sorghum grain substrate showed the highest protein content in the fruit bodies at both seasons followed by the mixture, wheat and maize grain substrate.

## 4. Discussion

Spawn quality, which is dependent on grain composition, is a critical factor that must be optimized to achieve successful and profitable mushroom farming [21]. Grain-carrying potential, which is the quality and quantity of the nutrients in grains that supports actively growing fungal cell during the transition to a cultivation substrate or during long term storage [22]. The objective of this study was to evaluate different grain as an alternative substrate for indigenous mushroom spawn production in Egypt. In the current study the spawn was developed on different kinds of cereals. The grain substrates were inoculated with mother spawn of *Pleurotus florida* mushroom and incubated for mycelial run. The incubation period varied among the different grain substrates [23]. In the current experiment, once the spawn was prepared, it was planted into rice straw substrate where they showed variable effect on duration of spawn run, primordial initiation and fruit body maturation which ranged from 15-33 days (from cultivation to first flush). The mixed grain substrates showed the least number of days to first flush. In agree with the current results Verma, Nath [24] investigated the effect of different grain substrates on the yield and growth parameters of *Pleurotus djamor* and P. ostreatus var. florida and found that maize grain substrate was the fastest for inoculation and fruit bodies maturity, while wheat performed the highest number of days to first flush. This may be due to the higher content of sorghum and mixed substrates from nitrogen, phosphorus and potassium [25]. Same suggestion was reported by Dahmardeh, Hossienabadi [26] who reported that the higher mineral content in sorghum cause better and faster mycelial growth which in role achieved the lowest number of days to first harvest. The current results showed that using maize, sorghum and the mixed substrate as a medium for spawning showed higher yield of oyster mushroom growing on rice starw. While, wheat grain substrate showed lower yield. this may be due to the different grains have different chemical composition. Sorghum and the mix grain substrate contain 2.24 and 2.01% nitrogen which explain the strong mycelium growth that’s in role showed higher mushroom yield. In accordance with the current results Khonga, Khare [27] studied the effect of different grain spawn on spawn quality and yield proving that Sorghum grains to be the best mycelium carriers. For oyster mushroom biological efficiency, it was clear from the current results that maize achieved the high biological efficiency and wheat showed the lowest values. In addition, the dry matter percentage varied from the first and second season. This may be due to the insignificant effect of the grain substrates on the biological efficiency and dry matter.

In the current investigation, the chemical composition of *Pleurotus* fruit bodies followed the same trend including nitrogen, phosphorus, potassium, protein and carbohydrates. The sorghum grain substrate showed the highest chemical composition in fruit bodies followed by the mixture the wheat and maize in both seasons. This is due to the higher nutritional value of the sorghum and the mix (1:1:1) as compared to other substrates that’s in role induce higher, better and healthy mycelial growth that affect the chemical composition of mushroom fruit bodies [21].

## 5. Conclusions

Depending on the current results and the previous studies, it is highly recommended to use sorghum grain substrate as a carrier for spawning which can improve the spawn quality and gaining faster and best growth achieving maximum yield that’s in role increase or maximize the profit.

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