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RESEARCH ARTICLE

The Evaluation of Different Feeds on Brine Shrimp, *Artemia parthenogenetica* Culture

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Key words:

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Abstract: In this study, *Artemia parthenogenetica* was fed with either *Spirulina* (S), yeast (Y), rice bran (R), oat (O) or their combinations in 10 experimental groups in triplicate for 20 days in laboratory conditions and growth, biomass, feed conversion rate (FCR), specific growth rate (SGR), survival rate, crude protein, crude lipid contents were determined. The highest average body length obtained at the end of the experiment was 2.805±0.003 mm in treatments (S) and (SYR), and the highest average individual dry weight was 23.057 µg in treatment (S). The mean biomass changed between 167.2±0.003 mg and 115.7±0.012 mg. The highest biomass value was 20.9 g/m^3 in treatment (S), followed by 20.5 g/m^3 in treatment (SYR). The highest FCR was found to be similar in (S) and (Y) with 1.14±0.02. SGR was 1.01±0.001 in all experimental groups. The highest survival rate was in treatment (S), and overall it ranged between 78.22±1.78-90.64±0.06%. The highest crude protein contents of *Artemia* were found in (SR) and (S) and the highest lipid content was found in treatment (O). As a result, it is thought that combinations of by-products such as rice bran and yeast together with microalgae will be economical in the cultivation of *Artemia parthenogenetica*.

Anahtar kelimeler:

Artemia parthenogenetica
Hipersalin sular
Üretim
Yemler
Zooplankton

Farklı Yemlerle Tuz Karidesi, *Artemia parthenogenetica* Üretiminin Değerlendirilmesi

Öz: Bu çalışmada, *Artemia parthenogenetica* laboratuvar koşullarında *Spirulina* (S), maya (M) pirinç kepeği (P), yulaf (Y) ve kombinasyonları ile 10 deneme grubunda üç tekerrürlü olarak, 20 gün süreyle beslenmişler ve büyüme, biyomas, yem değerlendirme oranı (YDO), spesifik büyüme oranı (SBO), yaşama oranı, ham protein, ham yağ içerikleri belirlenmiştir. Deneme sonunda elde edilen en yüksek ortalama uzunluk değeri 2,805±0,003 mm olarak (S) ve (SMP) gruplarında, en yüksek ortalama birey kuru ağırlık değeri 23,057±0,05 µg olarak (S) deneme grubunda ölçülmüştür. Elde edilen ortalama biyomas değerleri 167,2±0,003 mg ile 115,7±0,012 mg arasında değişmiştir. En yüksek biyomas değeri (S) deneme grubunda 20,9 g/m^3 olmuş, onu (SMP) deneme grubu 20,5 g/m^3 olarak izlemiştir. En iyi YDO (S) ve (M) deneme gruplarında (1,14±0,02) benzer bulunmuştur. SBO deneme gruplarında 1,01±0,001 olarak saptanmıştır. Yaşama oranı en yüksek (S)'de bulunmuş, bununla birlikte, deneme gruplarında %90,64±0,06 ile %78,22±1,78 arasında değişmiştir. Araştırma sonunda, *Artemia*'da, en yüksek ham protein oranları (SP) ve (S)'de, en yüksek yağ oranı ise sadece yulaf ile beslenen (Y) deneme grubunda saptanmıştır. Elde edilen sonuçlara göre, *Artemia parthenogenetica* yetiştiriciliğinde mikroalg ile birlikte pirinç kepeği ve maya gibi yan ürünlerle kombinasyonların ekonomik olacağı düşünülmektedir.

Introduction

Artemia spp. inhabit hypersaline waters and help formation of larger salt crystals and improves salt quality by controlling algal blooms for halobacterium growth, increasing heat absorption, accelerate evaporation and reducing the concentration of dissolved organics in salt lakes (Sorgeloos et al.,1986). Besides, *Artemia* is also important in aquaculture as live food for marine fish larvae and crustaceans (Bengston, 2003).

In lake ecosystems, climate and other environmental conditions can affect *Artemia* cyst production resulting in poor harvests which, in turn, may increase the price of *Artemia* cysts that potentially affect larval fish and shrimp

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farming throughout the world. In Turkey, 90% of *Artemia* cysts (50-70 tons cyst/year) used in larval fish culture is imported (Koru, 2017).

Since increasing cyst price is critical for aquaculture various *Artemia* sources have been identified and evaluated for commercial use such as Urmia Lake (Iran), Aibi Lake (China), and various salt lakes in Siberia, Kazakhstan and Argentina (Triantaphyllidis et al., 1998). In Turkey, local *Artemia* sources (*A. parthenogenetica*) are mainly from the Çamaltı Saltpan (İzmir) and Salt Lake (Aksaray). The production of *A. parthenogenetica* cysts has been carried out in Çamaltı Saltpan since 2013 and is commercially available for the last two years, particularly for the aquarium fish sector. However, local supply has met only 10-15% of the domestic demand (Koru, 2017).
In aquaculture, fish larvae is fed with *Artemia* in forms of decapsulated cysts or nauplii. Since Artemia growout using algae is expensive, some studies have focused on the production of Artemia with various agricultural waste products such as rice bran and corn flour in order to reduce the production cost. Notably, the results obtained with rice bran were satisfactory (Sorgeloos et al., 1980). In this respect, there is a need for studies on alternative foods on the growth of *A. parthenogenetica*.

In this study, the growth potential of *A. parthenogenetica*, using either dry microalgae (*Spirulina*), yeast, rice bran, oats or their combinations were investigated and the growth parameters, survival rates and their biochemical compositions such as crude protein and crude oil contents were determined.

Material and Methods

The study was conducted in the laboratory of the Department of Fisheries and Aquaculture Engineering, University of Ankara. *A. parthenogenetica* cysts were supplied in 2019 from salt pans of Çamaltı and hatchery process were carried out according to Lavens and Sorgeloos (1996) and Sorgeloos et al. (1986).

After hatching, *A. parthenogenetica* nauplii with yolk was placed as 2 nauplii /ml (8000 nauplii/tray) into shallow trays (38×28×8 cm) with a volume of 8 liters (Maldonado-Montiel and Rodriguez-Canche, 2005; Naegel and Gomez-Humaran, 1998; Naegel, 1998; Reeve, 1963; Vartak and Joshi, 2002). *A. parthenogenetica* nauplii were experimentally kept under the following culture conditions: 23±0.19 ºC water temperature, 40 g/l salinity, pH 8.29±0.00 and 5.84±0.02 mg/l dissolved oxygen (Sorgeloos et al.,1986). Nutritional content of *A. parthenogenetica* nauplii was about 54% protein, 25% lipid, 4.2% ash and 7% moisture (Triantaphyllidis et al., 1998).

In feeding trials, commercially available dried, ground and powdered *Spirulina* (S), yeast (Y), rice bran (R), oats (O) and their combinations in different ratios were used as feed (Table 1). A total of 10 treatments were tested in triplicate during a period of 20 days. Analyzes of the biochemical properties of the feeds are given in Table 2.

Table 1. Experimental design of the study

Treatment	Feed	Ratios (%)	Stocking rate
1	S	100	
2	SYR	50+25+25	
3	SYO	50+25+25	
4	SYRO	25+25+25+25	
5	SY	50+50	8000
6	SR	50+50	nauplii
7	SO	50+50	
8	Y	100	
9	R	100	
10	O	100	

(S) *Spirulina*, (Y) yeast, (R) rice bran, (O) oats

Table 2. Biochemical composition of *A. parthenogenetica* feeds (%)

Biochemical composition	*Spirulina*	Yeast	Rice bran	Oat
Protein	60.94 ±0.81	40.09 ±0.06	11.04 ±0.02	8.5 ±0.02
Lipid	4.57 ±0.04	4.3 ±0.09	12.34 ±0.21	4.61 ±0.04
Carbohydrate	28.07 ±0.79	48.08 ±0.08	57.61 ±0.23	61.75 ±0.03
Ash	6.05 ±0.01	4.73 ±0.02	8.24 ±0.02	8.57 ±0.02
Moisture	5.49 ±0.01	2.78 ±0.02	10.75 ±0.01	16.55 ±0.01

During the experiment, sea water in each tray was renewed on day 5^{th}, 8^{th}, 12^{th}, 15^{th}, 18^{th} and 20^{th}. Dead *Artemia* accumulated on the bottom of the trays were collected and counted to determine the survival rates (Agh et al, 2008; Triantaphyllidis et al., 1995).

The amount of feed given to each treatment corresponded to 10% of the *Artemia* biomass and was calculated daily (Zmora and Shpigel, 2006). Each diet was first homogenized using a blender (Sivaji, 2016) and sieved through a series of sieves with different mesh sizes (days 1-3: 30-50 µ, days 3-7: 50-150 µ, from 7th day >150 µ) in order to match particle size with developmental stage (Zmora and Shpigel, 2006). Daily ration was divided into 3 aliquats and given at 09:00, 13:00 and 18:00 (Garcia-Ulloa Gomez, 1999). However, the turbidity of the water in experimental groups were also taken into the consideration while feeding (Lavens et al., 1987; Lavens and Sorgeloos, 1987; Zmora and Shpigel, 2006).

During the experiment, the lengths of *Artemia* from the anterior margin of the head to the base of caudal furca

were measured daily using an inverted microscope. From each tray, three sub-samples of 25 ml were taken randomly and the mean lengths of 30 *Artemia* were measured (Abreu-Grobois, 1991; Amat, 1980**;** Coutteau et al.,1992; Lavens et al., 1987; Naegel, 1999).

In experimental groups, biomass was calculated as dry weight from the daily length measurements using the formula below (Abreu-Grobois, 1991).

$$DW\ (\mu g) = 10^{(-2{,}53+1{,}63\times\log(L)+0{,}81\times(\log(L))^2)} \times 10$$

DW = dry weight
L = lenght (mm)

The specific growth rate was calculated using the formula below within the experimental groups at the end of the study (Lavens and Sorgeloos, 1991).

$$SGR = \frac{\ln\frac{W_1}{W_0}}{T}$$

T = experiment time
In = logarithm of biomass
W_1 = *Artemia* biomass at final weight, µg dry weight
W_0 = *Artemia* biomass at initial weight, µg dry weight

Survival rate determined by collecting and counting dead individiuals on the 5th, 8th, 12th, 15th, 18th and 20th days when the water was renewed in trays (Agh et al., 2008; Triantaphyllidis et al., 1995).

Survival rate (%) = $(N_1 / N_0) \times 100$

N_1 = final counted individuals
N_0 = initial counted individuals

Feed conversion ratio (FCR) was calculated from the ratio of amount of total feed consumed (µg) to weight gained (µg) during the experiment (Lavens and Sorgeloos, 1991).

$$FCR = \frac{F}{W_1 - W_0}$$

F = consumed feed (µg)
W_1 = last weight of *Artemia*, µg dry weight
W_0 = initial weight of *Artemia*, µg dry weight

The length-weight relationships of the experimental groups were determined according to regression equation (b; confidence limits 95%) (Ricker, 1975).

$$W = aL^b$$

W = weight (µg)
L = lenght (mm)
a and b = polynomial equality constants

At the end of the experiment, after harvesting the adult *Artemia*, total raw protein and raw lipid contents of the samples for each experimental groups were determined according to (AOAC, 1990).

Statistical analysis were carried out by using SPSS 26 Statistic Program. Variance analysis (One way-ANOVA) and Duncan multiple range test were used to determine significant differences among treatments (Kesici and Kocabaş, 2007).

Results

Our findings indicated that differences in the mean length and weight values in treatments (S-%100), (SYR-%50+25+25), (SYO-%50+25+25), (SYOR-%25+25+25+25), (SY-%50+50), (SR-%50+50), (SO-%50+50) were statistically significant ($P<0.05$). No significant differences were found between treatments (Y-%100), (R-%100) and (O-%100) ($P>0.05$). There was a steady increase in the mean weight and length which was similar until day 16th. After day 16, the mean length and weight values treatments (S) and (SYR) were higher than those of other treatments (Figure 1-4). Total length and weight showed the same growth pattern in all experimental groups and r^2 was very close to 1 (Figure 5).

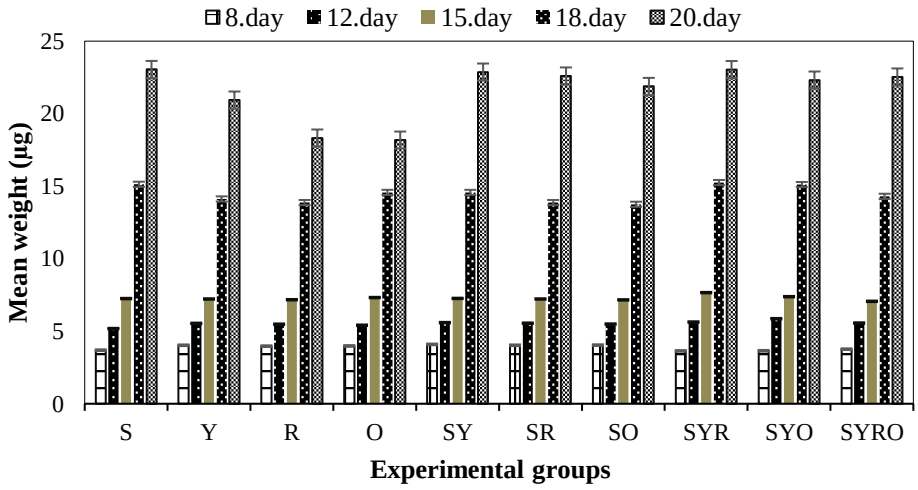


Figure 1. Mean weight values of *A. parthenogenetica* in experimental groups (µg)

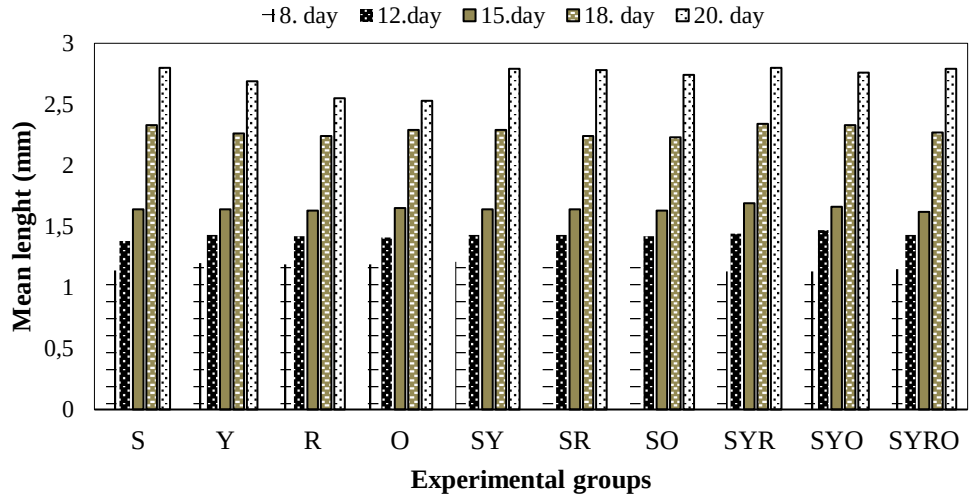


Figure 2. Mean lenght values of *A. parthenogenetica* in experimental groups (mm)

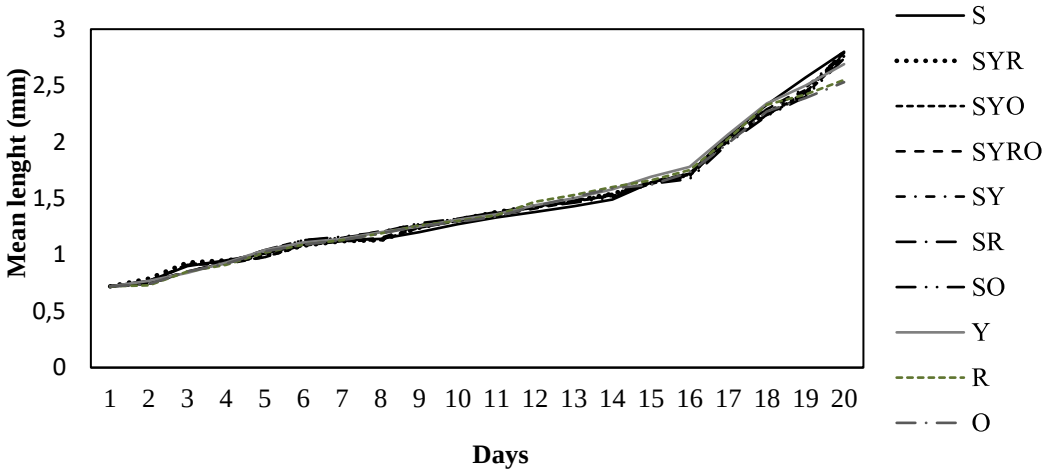


Figure 3. The mean lenght values in experimental groups (mm)

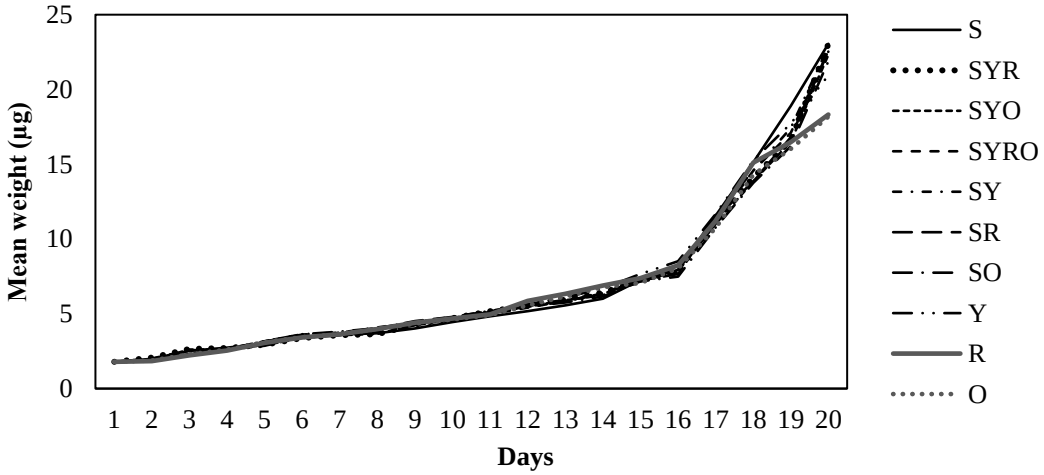
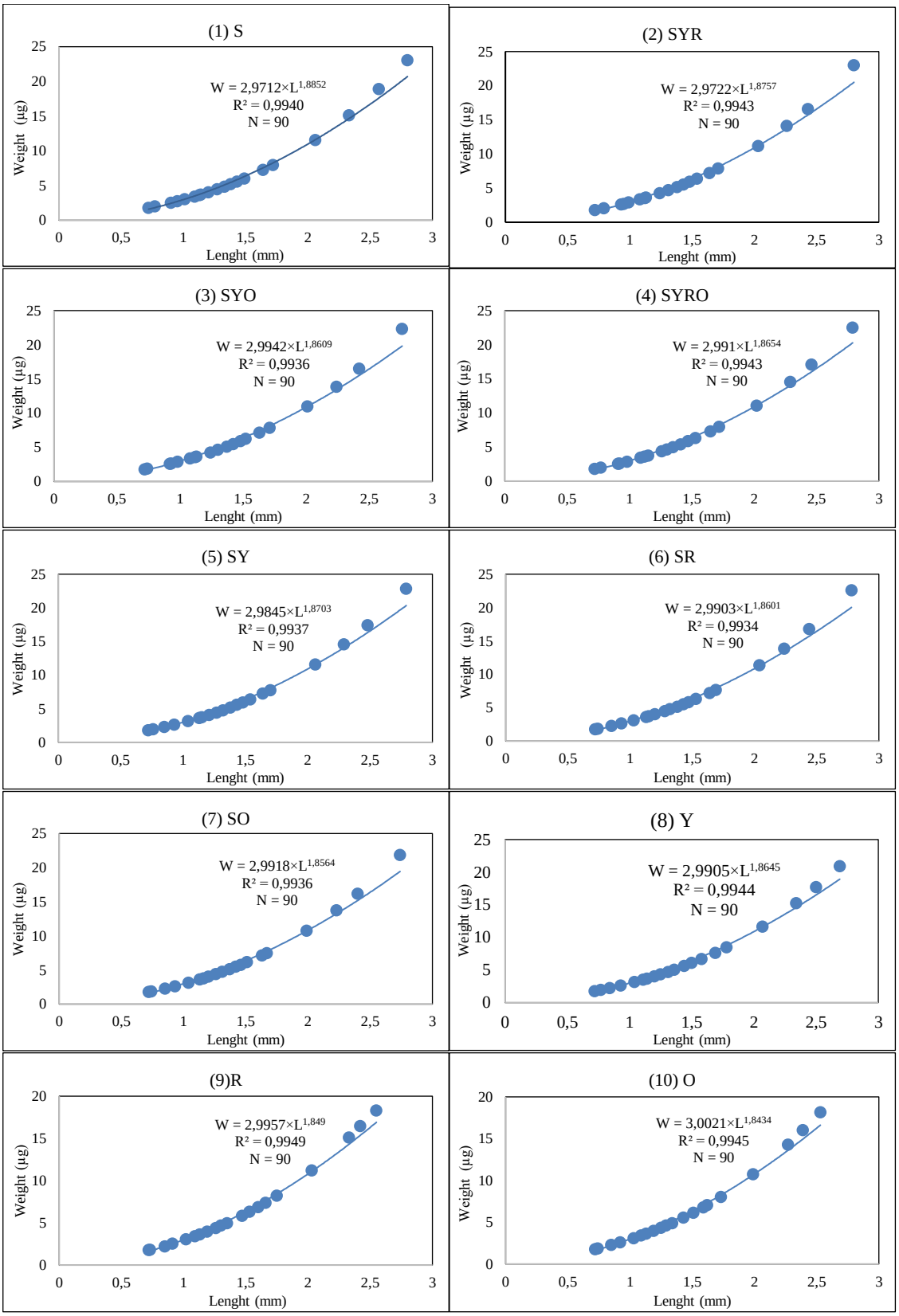


Figure 4. The mean weight values in experimental groups (µg)



S) *Spirulina*, (Y) yeast, (R) rice bran, (O) oats

Figure 5. Lenght-weight relationships of *A. parthenogenetica* in experimental groups

The differences between mean biomass values were found to be statistically significant (P<0.05). Specific growth rate values were found to be similar in all treatments and the observed differences were not statistically significant (P>0.05). At the end of the experiment, mean feed convertion rates were calculated and the differences between the experimental groups were found to be statistically significant (P<0.05). The differences in the mean survival rate values between the experimental groups were found to be statistically significant (P<0.05) (Table 3).

The differences between the mean crude protein and crude lipid values of *A. parthenogenetica* fed with different feeds and their combinations in experimental groups were found to be statistically significant (P<0.05) (Table 4).

Table 3. Mean values ± SD of biomass, feed conversion rate, spesific growth rate and survival rate values in experimental groups

Experimental groups	Biomass (g)	Specific growth rate	Feed conversion rate	Survival rate (%)
1 (S)	**0.1672 ±0.003^{a*}**	1.01 ±0.001	**1.14 ±0.020^{d}**	**90.64 ±0.06^{a}**
2 (SYR)	0.1644 ±0.003^{b}	1.01 ±0.001	1.19 ±0.001^{cd}	89.17 ±0.07^{b}
3 (SYO)	0.1561 ±0.003^{d}	1.01 ±0.001	1.24 ±0.040^{bcd}	87.28 ±0.11^{c}
4 (SYRO)	0.1609 ±0.003^{c}	1.01 ±0.001	1.50 ±0.290^{a}	89.25 ±0.14^{b}
5 (SY)	0.1523 ±0.003^{e}	1.01 ±0.001	1.31 ±0.040^{bcd}	83.03 ±0.26^{e}
6 (SR)	0.1511 ±0.002^{f}	1.01 ±0.001	1.31 ±0.010^{bcd}	83.53 ±0.24^{de}
7 (SO)	0.1457 ±0.003^{g}	1.01 ±0.001	1.39 ±0.010^{ab}	83.21 ±0.25^{e}
8 (Y)	0.1416 ±0.003^{h}	1.01 ±0.001	**1.14 ±0.020^{d}**	84.55 ±0.33^{d}
9 (R)	0.1174 ±0.002^{i}	1.01 ±0.001	1.36 ±0.040^{abc}	78.22 ±1.78^{g}
10 (O)	0.1157 ±0.002^{j}	1.01 ±0.001	1.31 ±0.040^{bcd}	79.55 ±0.12^{f}

*Mean values with different small letters in the same column is statistically significant (p<0.05)
(S): *Spirulina*, (Y): yeast, (R): rice bran, (O): oats

Discussion and Conclusion

In this study, *A. parthenogenetica* cysts (Çamaltı Saltpan: batch of 2019) were hatched at 27 ºC, 30 g/l salinity, pH 8.5 under a light density of 2000 lux. The feeding experiment was carried out at 23±0.19°C water temperature, 40 g/l salinity, pH 8.29±0.00. Bozok (1996), reported that *Artemia* cysts from Çamaltı hatched within 48 hours at 30 °C water temperature and 35 g/l the salinity. The hatching time in this study was shorter due possibly to lighting application. It is reported that the optimal performance of *A. parthenogenetica* in the Çamaltı Saltpan under natural conditions was at temperatures between 27 °C – 30 °C and salinities between 35 -100 g/l (Koru, 2004). Under laboratory conditions *A. parthenogenetica* couldn't tolerate water temperature of 30 °C and the best performance for salinity was about 80g/l (Saygı, 2004). Kuruppu and Ekaratne (1995) reported that the survival rate of young individuals of the parthenogenetic *Artemia* was very low between 65-140 ppt salinity and 35 °C. Browne and Wanigasekera (2000) also indicated that increasing salinity and temperature resulted in lower survival rates of *A. parthenogenetica*. In this study, the optimal temperature and salinity values for *A. parthenogenetica* which were fed in laboratory conditions were about 23°C and 40 g/l, respectively. It has been observed that *Artemia* deaths occured as a result of decreasing dissolved oxygen values when water temperature and salinity increased.

The initial mean length and weight of *A. parthenogenetica* were 0.726±0.005 mm 1.815±0.02 µg, respectively. During the experimental period, a linear increase in length and weight values were observed in all experimental groups. The correlation coefficient in the experimental groups varied between 0.9934 and 0.9949. The specific growth rate supported the length-weight relationship of *A. parthenogenetica* and was determined as 1.01±0.00 in all of the experimental groups. In the experiment, it was observed that there was a significant increase in the growth of *A. parthenogenetica* after day 16 in all experimental groups. Islam et al., (2019) reported that the sharp growth in *Artemia* fed with a mixture containing rice bran was recorded between days 11-13 of the experiment and did not change after the 14th day at 25 °C water temperature. In this study, lower water temperature resulted in a slower growth rate until day 16.

Table 4. Mean values ± SD of crude protein and crude lipid values of *A. parthenogenetica* fed with different feeds and their combinations in experimental groups.

Experimental groups	Crude Protein (%)	Crude Lipid (%)
1(S)	10.27 ±0.01^{b*}	0.29 ±0.01^{e}
2(SYR)	3.63 ±0.02^{f}	0.38 ±0.01^{cd}
3(SYO)	3.48 ±0.01^{h}	0.36 ±0.02^{d}
4(SYRO)	3.69 ±0.01^{e}	0.20 ±0.02^{f}
5(SY)	3.11 ±0.01^{j}	0.27 ±0.01^{e}
6(SR)	**10.85 ±0.01^{a}**	0.41 ±0.01^{bc}
7(SO)	6.12 ±0.01^{c}	0.43 ±0.01^{b}
8(Y)	3.52 ±0.01^{g}	0.36 ±0.01^{d}
9(R)	3.15 ±0.01^{i}	0.37 ±0.01^{d}
10(O)	4.02 ±0.01^{d}	**0.62 ±0.01^{a}**

*Mean values with different small letters in the same column is statistically significant ($p<0.05$). (S): *Spirulina*, (Y): yeast, (R): rice bran, (O): oats.

The mean individual length in all treatments varied between 2.532±0.002 mm and 2.805±0.003 mm. The highest mean lengths were measured in treatments (S) and (SYR) with 2.805 mm and in the (SY) group with 2.796 mm, followed by (SR), (SYRO), (SYO), (SO), (Y), (R) and (O), respectively. In treatments that did not receive *Spirulina*, the mean lengths of *A. parthenogenetica* varied between 2.693 mm and 2.532 mm. The mean individual weights in the experimental groups varied between 23.057±0.05 µg and 18.181±0.03 µg. The highest mean dry weight value was measured as 23.057 µg in treatment (S), followed by (SYR), (SY), (SR), (SYRO), (SYO), (SO), (Y), (R) and (O), respectively. In an earlier study, differences in the lenght and weight of *Artemia* resulted from the biochemical characteristics of the feeds such as crude protein and crude oil contents (Maldonado-Montiel and Rodriguez-Canche, 2005). The feeds given to the experimental groups were prepared as dried-powdered; the highest protein content was measured in diet containing *Spirulina* (60.94%), followed by yeast, rice bran and oats, respectively. The highest lipid content was determined in rice bran (12.34%), followed by oat, *Spirulina* and yeast, respectively. Therefore, growth in length and weight was found to be higher in treatments containing *Spirulina,* (S) and a combination of *Spirulina* and yeast, and rice bran (SYR). It has been reported that that *Spirulina*, which is rich in protein provides optimal growth in *Artemia* (Sivaji, 2016; Vartak and Joshi, 2002). However, algae cultivation is costly and requires labor.

The mean biomass values varied between 115.7 ± 0.00-167.2 ± 0.00 mg in the 8 x10^{-3} m^3 culture volume at the end of the experiment. The highest mean biomass value was found in treatment (S) followed by treatments (SYR), (SYRO), (SYO), (SY), (SR), (SO), (Y), (R) and (O), respectively. The highest biomass value was achieved in treatment that received only *Spirulina* with 20.9 g/m^3, followed by 20.6 g/ m^3 in (SYR) which received a combination of *Spirulina*, yeast and rice bran.

Mean feed conversion rates varied between 1.14±0.02 and 1.50±0.29. The highest feed conversion rates were found in treatments (S) and (Y), followed by (SYR), (SY), (SR) and (O), (SYO), (R), (SO) and (SYRO), respectively. Although feed conversion ratio was 1.14±0.02 in treatment (O) fed with only yeast, the growth was poor. Despite a higher crude protein content of yeast which is around 40%, it has been shown that it is appropriate to use it in combination with other feeds, since it is insufficient in terms of other nutrients. This result supports the findings of Coutteau and Sorgeloos (1989) and Dhont and Van Stappen (2003). In experimental groups that received oat, rice bran and their combinations, higher feed conversion rates were determined due to the physical characteristics of those feeds. Feeds containing oat and rice bran have a tendency to easily form aggregates in water, and therefore can no longer be ingested by the *Artemia* and may clogg the *Artemia* retaining filter limiting the food intake. This view is supported by the notification of (Lavens et al., 1987). As indicated by (Coutteau and Sorgeloos, 1989), various environmental factors such as food quality, quantity, life stage and growing conditions affect the feeding behavior such as food filtration rate, digestion rate and nutrient absorption of *Artemia*.

Survival rates were generally high in the experimental groups and found between 78.22±1.78-90.64±0.06%. The highest survival rate was determined in treatment (S) fed with only *Spirulina*, followed by (SYRO), (SYR), (SYO), (Y), (SR), (SO), (SY), (O) and (R), respectively. Vahdat and Oroujlou (2021) fed *A. franciscana* with algae and agricultural products and determined the highest survival rate as 56% in the group fed with algae followed by 48.67% in the group fed with rice bran. In the 5-day feeding study of *A. parthenogenetica*, the survival rate was found to be 76% in the group fed with *Spirulina* and 66% in the group fed with rice bran (Sivaji, 2016). These values are below the lowest value determined in this study. Basbug et al., (2002) reported that *Artemia* grew faster but survival rate was lower as the temperature increased and indicated that for the development from the nauplius stage to the adult stage, 30 days at 18 °C, 20 days at 24 °C and 15 days at 30 °C were required. However, the daily feeding amounts were determined based on the live weights of *A. parthenogenetica* and the water turbidity in the trays was also taken into consideration. This supports the high survival rates in the experimental groups.

In this study, mean crude protein changed between 10.85±0.01% and 3.11±0.01% and mean crude lipid changed between 0.62±0.01% and 0.20±0.02%. The highest mean crude protein content was found in treatments (SR) and (S), respectively. The highest mean crude lipid content was found in treatment (O) fed only oats. Maldonado-Montiel and Rodriguez-Canche (2005) found the highest crude protein content of *Artemia* sp fed

with combination of rice bran and algae. Their findings support the results of this research. The crude protein and crude lipid contents are not similiar in wild and cultured *Artemia* species. Crude protein and crude lipid contents were 50.2-58.0% and 2.4-19.3% for wild *A. franciscana* and 39.4-64.0% and 4.5-12%, for cultured *A. franciscana* respectively, In *A. parthenogenetica* (Italy) the crude protein and crude lipid contents were determined as 41.9% and 3.5% from wild, 55% and 4.0% under laboratory conditions, respectively (Dhont and Van Stappen, 2003). Although there are studies on the biochemical characteristics of early stages of wild *Artemia* populations in Turkey, studies on adult *Artemia* populations is lacking. For the nauplii stage of *Artemia* populations in Çamaltı Saltpan, lower total fatty acids levels were reported and docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) enrichment were suggested (Koru and Dıraman, 2003).

In this study, it was revealed that there was a linear increase in the growth and biomass values of *A. parthenogenetica* fed with four different feeds and their combinations in the experimental groups. However the mean crude protein and lipid contents of *A. parthenogenetica* were found to be lower than expected. Itwas reported that carbohydrate content of the oat was high but since the starch in oat contained amylase-oil complex, it was also rich in crude lipid (Lasztity, 1998). This explains the higher crude lipid content in the experimental group fed only oats (O) compared to the other treatments. Although rice bran is rich in lipid, it has been reported that its nutritive value is a factor of the manufacture process (Rosniyana et al., 2007). The protein quality of feeds depends on their amino acid composition and its biological availability. However, the quality of the feed can not be determined by just biochemical analyses. The real quality of the feed should be evaluated from the growth, feed conversion and survival of the target species (Maldonado-Montiel and Rodriguez-Canche, 2005).

As conclusion, *Artemia parthenogenetica* was fed with four different feeds and their combinations in 10 experimental groups during a period of 20 days. The mean lenght and weight values in all experimental groups showed a linear increase and survival rates were high. However, the highest values were determined in the experimental group fed *Spirulina*. In the combination prepared with *Spirulina*, rice bran and yeast, the values were close to the values in the group fed only with *Spirulina*. In the feeding of *Artemia*, algae are important both in the wild and culture conditions as demonstrated repeatedly in other studies. Since algae production is expensive, it is recommended to use agricultural products as complementary foods in the cultivation of *Artemia* for low cost and labor savings. However, all the feeds and combinations had a positive effect on growth of *A. parthenogenetica*. Biochemical properties of *Artemia* populations can be manipulated through enrichment based on the needs of marine fish larvae. This property of *Artemia* promotes its widespread use as live feed in aquaculture. In this respect, findings of this study are valuable for further studies on the growth and survival of *A. parthenogenetica* under culture conditions.

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Conflict of Interest

The authors declared that there is no conflict of interest.

Author Contributions

Abdolsaleh Qaranjiki: methodology, investigation, writing. Mine Kırkağaç: material support, methodology, statistical analysis, writing and preparation of the article for publishing.

Ethics Approval

Artemia as an invertebrate, this research didn't required ethics committee approval.

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