ORIGINAL ARTICLE

COMPARISON OF BACTERIAL PROBIOTICS (*BIFIDOBACTERIUM* AND *LACTOBACILLUS*) VERSUS FUNGAL PROBIOTICS (*SACCHAROMYCES*) IN THE TREATMENT OF ACUTE DIARRHOEA IN CHILDREN AGED 6 MONTHS TO 5 YEARS

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Background: Acute diarrhoea among children mainly due to infection must be treated prophylactically to reduce mortality. The objective of this study was to compare the outcome of using bacterial probiotics (*Bifidobacterium* and *Lactobacillus*) versus fungal probiotics (Saccharomyces) for acute diarrhoea among children aged 6 months to 5 years. **Methods:** A non-randomized control trial was conducted at diarrhoea ward, the Children's Hospital, Lahore from 1st March 2022 to 1st March 2024. 200 children were recruited in the study using non-probability consecutive sampling technique which were divided equally into two groups receiving either bacterial probiotics or fungal probiotics. The children were followed up till resolution of diarrhoea. Diarrhoeal duration and stool frequency were noted. Data was entered and analysed using SPSS Version 26. **Results:** Out of 200 children, 52.5% were male and 47.5% were female. Mean age of the sample was 2.24±1.54 years, mean baseline and follow up diarrhoea duration was 3.52±1.44 and 3.47±1.25 days and stool frequency at follow up was 3.75±1.15. Complete diarrhoeal resolution was seen among 95% of the children using bacterial probiotics while 87% of the children using fungal probiotics (p=0.048). Regarding diarrhoeal duration (days) among the two groups, the mean was 3.11±1.36 (bacterial probiotic group) and 3.88±1.02 (fungal probiotic group) (p<0.001) and regarding stool frequency, the mean was 2.97±0.55 (bacterial probiotic group) and 4.57±1.07 (fungal probiotic group) (p<0.001). **Conclusion:** It can be concluded from this study that diarrhoeal resolution along with stool frequency was better among children using bacterial probiotics as compared to those using fungal probiotics.

Keywords: Acute Watery Diarrhoea; Bacterial Probiotics; Fungal Probiotics

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INTRODUCTION

The passage of loose or watery stools at least three times in a 24-hour period is defined as diarrhoea which is the most common public health problem in the developing world. It is the leading cause of death in children under the age of five years, with an estimated 1.5 to 2 million deaths per year worldwide. In countries with limited resources, the infants have more risk of acquiring diarrhoea, i.e., six episodes (median) per annum; while in high income countries, children on an average have three episodes (median) per annum.[1,2] Probiotics are the live microorganism that are given to the host in order to improve their health by treating or preventing infections caused by pathogens. Different single and multi-strain probiotics such as *Lactobacillus rhamnosus* GG and *Saccharomyces boulardii* are being recommended specifically in the treatment of diarrhoea. There is also new information on *Lactobacillus Rhamnosus* GG survival in children receiving amoxicillin/clavulanate therapy. *Saccharomyces boulardii* is non-pathogenic yeast that has a direct inhibitory effect on many pathogens, as well as an anti-secretory and trophic effect on enterocytes.[3–5]

Probiotics are acknowledged for their health benefits and consist of sufficient amounts of live bacteria of non-pathogenic nature that includes *Bifidobacterium*, Yeast, *Lactobacillus*, *Enterococcus* and *Bacillus clausii* etc. These microorganisms have been extensively recognized for treating diarrhoea caused by pathogens through maintaining or enhancing the gut microbiota balance. These mechanisms include inhibiting the harmful bacteria colonization through competition especially for nutrients as well as antibacterial compounds production.[6] A study

conducted previously found out that the mean duration of diarrhoea after starting the treatment with fungal probiotics was 41.68±10.84 hours and 53.33±16.78 hours with bacterial probiotics for management of diarrhoea (p<0.05), showing that fungal probiotics are more effective and reduce the duration of diarrhoea and its treatment.[7] Khan and Munir conducted a study in Pakistan to determine the outcome of probiotics in the treatment of acute diarrhoeal episodes among children aged 5 months to 5 years in comparison to the controls. Improvement was noted in 92% of the patients being treated with Probiotics as compared to 71% patients in the control group. The researchers suggested that the probiotics were significantly more effective in reducing the stool frequency in acute diarrhoea.[8]

Literature has shown that bacterial probiotics are more helpful in reducing the duration of acute diarrhoea, resulting in early recovery in comparison to varied data showing the effectiveness of fungal probiotics in treating acute diarrhoea. The objective of this study was to determine the better treatment option for acute diarrhoea, so that in future, we may plan a strategy to manage diarrhoea with better type of probiotics. This would help to improve our practice and management protocols in local settings.

MATERIAL AND METHODS

It was a non-randomized control trial (Quasi experimental study) conducted from 1st March 2022 to 1st March 2024. The data was collected from department of paediatric medicine & diarrhoea ward, emergency department, The Children's Hospital & University of Child Health Sciences, Lahore after obtaining formal permission from institutional review board vide No. 2021-253-CHICH. A sample size of 200 was calculated with confidence interval of 95% with 90% power of study and taking mean duration of diarrhoea, i.e., 41.68±10.84 hours with fungal probiotics and 53.33±16.78 hours with bacterial probiotics for management of diarrhoea.[7]

Children aged 6 months to 60 months (5 years) of both gender and diagnosed with acute diarrhoea (>3 loose watery stool for 2-7days), willing to participate were included in the study through non-probability consecutive sampling technique. About 250 children with history of severe malnutrition (on medical record), renal failure, liver disease or diabetes (on medical record), recurrent episode of diarrhoea within 15–20 days, congenital anomalies (down syndrome, turner syndrome, chromosomal abnormality, congenital heart disease, congenital spinal disease, muscular dystrophy) and already taking probiotics at the time of enrolment were excluded from the study.

An informed consent was taken from parents. Demographic details (name, age, gender, height and weight of child, duration of diarrhoea, socioeconomic status, residential area and water use) were noted. Children were divided into two groups by attendants/guardians' choice. In group A, children were given 1 sachet of bacterial probiotics i.e., *Bifidobacterium animalis* subspecies *lactis*& Bifidum and *Lactobacillus* subspecies *rhamnosus* & *Acidophilus* in water 12 hours apart. In group B, children were given 1 sachet of fungal probiotics, i.e., *Saccharomyces boulardii* in water 12 hours apart. All children were managed as per standard management protocol and standard diarrhoea treatment was given to all of them. Children remained admitted in paediatric wards and followed-up there till resolution of diarrhoea. Total duration of diarrhoea and stool frequency was noted for all the children enrolled in the study. The data was entered, cleaned and analysed on SPSS version 26. Quantitative variables like age, height, weight, duration of diarrhoea before and after treatment were presented in the form of mean and standard deviation. Qualitative (Categorical) variables like gender, socioeconomic status, residential area, and type of water source were presented in the form of frequency and percentage. Both groups were compared for diarrhoeal resolution and mean duration of diarrhoea, stool frequency by using chi-square and independent samples t-test respectively. p-value ≤0.05 was considered a significant. All ethical considerations ensured at every step of this study. Autonomy of the respondents along with confidentiality of data was ensured.

RESULTS

Among 200 patients (100 each in both groups), the overall mean age was 2.24±1.54 years; mean height was 81.92±15.76 cm; mean weight was 11.71±3.86 Kg; mean baseline diarrhoea was 3.52±1.44 days, mean diarrhoea duration at follow up was 3.47±1.25 days, stool frequency at follow up was 3.75±1.15. 105 (52.5%) children were male while 95 (47.5%) were female. Socioeconomic status showed that 50 (25%) children belonged to low/poor social class and remaining 150 (75%) children belonged to middle class families. Twenty (10%) were living in rural areas and 180 (90%) were living in urban area. According to the results 73 (36.5%) children were using tap water as their drinking water source, 25 (12.5%) children used boiled water and 102 (51%) were using filtered water. Among children using bacterial and fungal probiotics, 95 (95%) and 87 (87%) children respectively showed diarrhoeal resolution (p=0.048) (Figure 1).

The table 1 showed that there was significant difference found with the mean comparison of diarrhoeal duration and stool frequency within the treatment groups; regarding diarrhoeal duration, among the bacterial and fungal probiotics group it was 3.11±1.36 in comparison to 3.88±1.02 (p<0.001). Regarding stool frequency, among the bacterial and fungal probiotics group it was 2.97±0.55 and 4.57±1.07 respectively (p<0.001).

The table 2 showed that the mean comparison of diarrhoeal duration and stool frequency within the treatment groups stratified by age and water source; in children aged ≤2 years regarding diarrhoeal duration, among the bacterial and fungal probiotics groups, it was 3.41±1.98 and 3.97±1.03(p=0.132). Whereas, stool frequency, among the bacterial and fungal probiotics group having age≤2 years, it was 2.97±0.58 and 4.72±1.14 (p<0.001). Whereas, in children aged >2 years regarding diarrhoeal duration, among the bacterial and fungal probiotics group it was 2.91±0.58 and 3.82±1.01(p<0.001). Regarding stool frequency, among the bacterial and fungal probiotics group having age>2 years, it was 2.96±0.54 in comparison to 4.47±1.03(p<0.001). Regarding water source, children using tap water regarding diarrhoeal duration, the bacterial and fungal probiotics group it was 3.54±1.93 and 4.20±0.86(p=0.087). Regarding stool frequency, among the bacterial and fungal probiotics group using tap water, it was 3.10±0.60 in comparison to 4.93±0.84 (p<0.001). Whereas, in children using boiled water regarding diarrhoeal duration, among the bacterial and fungal probiotics group was 2.92±0.64 and 3.60±0.84 (p=0.04). Regarding stool frequency, among the bacterial and fungal probiotics group using boiled water, it was 3.0±0.0 and 3.80±0.42 (p<0.001). On the other hand, in children using filtered water regarding diarrhoeal duration, the bacterial and fungal probiotics group showed mean of 2.79±0.60 and 3.75±1.10 (p<0.001). Regarding stool frequency, among the bacterial and fungal probiotics group using filtered water, it was 2.84±0.57 in comparison to 4.52±1.20 (p<0.001).

Figure-1: Graphical presentation of children according to Diarrhoea resolution (n=200)

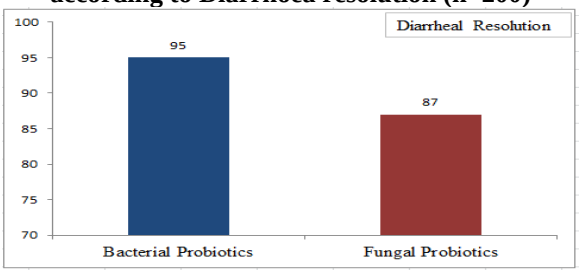

Table-1: Mean comparison of diarrhoeal duration and stool frequency at follow up among treatment groups

Variables	Group	n (Number of children)	Mean	SD	*p*-value	Remarks
Diarrhoeal Duration	Bacterial Probiotics	95	3.11	1.36	<0.001	Significant
	Fungal Probiotics	87	3.88	1.02		
Stool Frequency	Bacterial Probiotics	95	2.97	0.55	<0.001	Significant
	Fungal Probiotics	87	4.57	1.07		

Table-2: Mean comparison of diarrhoeal duration and stool frequency at follow up among treatment groups stratified by age groups and water source

Variables		Treatment Groups	n (Number of children)	Mean	SD	*p*-value	Remarks
Age≤2	Diarrhoeal Duration	Bacterial Probiotics	39	3.41	1.98	0.132	Insignificant
		Fungal Probiotics	36	3.97	1.03		
	Stool Frequency	Bacterial Probiotics	39	2.97	0.58	<0.001	Significant
		Fungal Probiotics	36	4.72	1.14		
Age>2	Diarrhoeal Duration	Bacterial Probiotics	56	2.91	0.58	<0.001	Significant
		Fungal Probiotics	51	3.82	1.01		
	Stool Frequency	Bacterial Probiotics	56	2.96	0.54	<0.001	Significant
		Fungal Probiotics	51	4.47	1.03		
Tap Water	Diarrhoeal Duration	Bacterial Probiotics	39	3.54	1.93	0.087	Insignificant
		Fungal Probiotics	29	4.20	0.86		
	Stool Frequency	Bacterial Probiotics	39	3.10	0.60	<0.001	Significant
		Fungal Probiotics	29	4.93	0.84		
Boiled	Diarrhoeal Duration	Bacterial Probiotics	13	2.92	0.64	0.04	Significant
		Fungal Probiotics	10	3.60	0.84		
	Stool Frequency	Bacterial Probiotics	13	3.00	0.00	<0.001	Significant
		Fungal Probiotics	10	3.80	0.42		
Filtered	Diarrhoeal Duration	Bacterial Probiotics	43	2.79	0.60	<0.001	Significant
		Fungal Probiotics	48	3.75	1.10		
	Stool Frequency	Bacterial Probiotics	43	2.84	0.57	<0.001	Significant
		Fungal Probiotics	48	4.52	1.20		

DISCUSSION

Globally diarrhoea ranks second as the leading cause of mortality in children under five years of age, emphasizing the critical importance of early management to prevent significant morbidity and mortality.[9] During the last few decades, probiotics remained an extensively studied subject for the treatment of paediatric diarrhoeal infections. They offer benefits of being less invasive as well as more effective. Various probiotic agents, including *Bifidobacterium, lactobacillus*, and *Saccharomyces boulardii*, have been employed for treating acute watery

diarrhoea, with Bifidobacterium and Lactobacillus demonstrating proven efficacy and no adverse effects.[10] In our study we compared bacterial probiotic against the fungal probiotic in the treatment of acute diarrhoea among young children to find out which type of probiotic is more effective and potent in reducing the frequency and resolution of acute watery diarrhoea among young children. In this study, overall mean baseline diarrhoea (in terms of days) was 3.52±1.44 days, mean diarrhoea duration at follow up was 3.47±1.25 days and stool frequency at follow up was 3.75±1.15. The diarrhoeal resolution among children using bacterial probiotics was 95% and among fungal probiotics it was 87% (p=0.048). On the basis of study groups, children among the bacterial probiotics group showed mean diarrhoeal frequency was 3.11±1.36 in comparison to fungal probiotics was 3.88±1.02 (p<0.001). Regarding stool frequency, among the bacterial probiotics group it was 2.97±0.55 in comparison to fungal probiotics was 4.57±1.07 (p<0.001).

On comparing with other studies from literature, one trial reported that the mean duration of diarrhoea after starting treatment was 6.6±1.7days with fungal probiotics and 4.1±1.3 days with bacterial probiotics for management of diarrhoea (p<0.05), showing that bacterial probiotics are more effective and reduce the duration of diarrhoea and its treatment.[11] These results are consistent with the findings of our study which also showed that bacterial probiotics are more effective than fungal probiotics in the treatment of acute diarrhoea in young children. A randomised controlled trial on 120 children carried out in Bangalore, India found out that the mean duration of diarrhoea after starting the treatment was 41.68±10.84 hours with fungal probiotics and 53.33±16.78 hours with bacterial probiotics for management of diarrhoea (p<0.05), showing that fungal probiotics are more effective and reduce the duration of diarrhoea and its treatment.[7] These results are in contradiction to the results found in our study which showed bacterial probiotics are better and more effective in reducing the duration and frequency of diarrhoea in children under 5 years of age. The possible reasons for this contradiction in the results may be attributed to the difference in study design, sample size, different bacterial probiotic used for the treatment of diarrhoea in both studies and the difference in local dietary practices. The study conducted by Khan and Munir in Peshawar, Pakistan noted improvement among 92% young children admitted with acute diarrhoea who were put on Probiotics and ORS while 71% patients of the control group put only on ORS had shown improvement. The researchers suggested that the probiotics were significantly more effective in reducing the stool frequency in acute diarrhoea.[8] The results shown in this research agree with the findings of our study that probiotics are effective in the treatment of acute diarrhoea in young children.

A similar study in Pakistan by Awais and colleagues comparing the clinical efficacy of bacteria-based probiotics with fungi-based probiotics for the treatment of acute watery diarrhoea showed clinical efficacy in both groups as 57.33% in group A and 28% in group B (p-value=0.0001). Hence, clinical efficacy of bacteria-based probiotics was higher than fungi-based probiotics in the treatment of acute watery diarrhoea as found in our study.[12]

In a contrary study, the efficacy of *Saccharomyces boulardii* as a probiotic was significantly higher (53%) among children compared to controls (47%). The study indicated a higher prevalence of diarrhoea in children under the age of 4, with a decreasing trend in older children, highlighting the susceptibility of infants and younger children to organisms causing acute diarrhoea.[12] The findings of this study are confirming the results shown in our research that probiotics are more helpful in treating acute watery diarrhoea in young children. The findings of our study also align with previous research conducted by Shati et al in Southwestern Saudi Arabia showing a higher prevalence of diarrhoea in children under 2 years of age than those between 2-5 years old.[13]

Gender-based analysis revealed an equal frequency and severity of acute diarrhoea in both genders. Probiotics, both bacterial and fungal, demonstrated significant clinical efficacy in treating diarrhoea. Lactobacillus was effective in 57.33% of cases, while Saccharomyces showed a clinical efficacy of 42.67%.[14] The bacterial-based probiotics in group A exhibited a higher clinical efficacy than the fungal-based probiotics in group B. These findings are consistent with other studies including our research findings, suggesting that bacterial probiotics may be more effective than fungal probiotics in treating diarrhoea.[14] The findings are similar to the present study results in terms of the age group affected by acute watery diarrhoea. Frequency & severity related to acute diarrhoea was same for both males and females i.e. group A (52%) and group B (58.67%) males affected by diarrhoea, while group A (48%) and group B (41.33%) females affected by diarrhoea.[15] A study by Mahmud et al., found out that diarrhoea causing dehydration was more prevalent in girls when they presented to the hospital as compared to the boys, which contradicts the current study findings.[16] Our results showed that both bacterial and fungal probiotics showed significant clinical efficacy in diarrhoea treatment. Another study revealed that it is beneficial in the treatment of diarrhoea in children.[17]

In the fungal probiotic group *Saccharomyces boulardii* showed clinical efficacy of 85%. A study conducted on beneficial effects on *Saccharomyces boulardii* also showed that it is a safe and effective remedy in treating acute diarrhoea.[12] Dinleyici *et al*. conducted a study examining the effectiveness of *Saccharomyces boulardii* in patients with acute diarrhoea across different settings, including the emergency department, outpatient department, and hospitalized patients. The study assessed parameters such as the frequency of stools, duration of hospital stays, and emergency department stay. The

probiotic group exhibited a significantly shorter duration of diarrhoea compared to the control group.[18] In a review by Guarino et al. on the use of probiotics for acute gastroenteritis, findings were mixed. While seven studies did not recommend probiotic use for gastroenteritis, five studies supported its use. *Saccharomyces boulardii* and *Lactobacillus rhamnosus* emerged as the most effective strains for use as probiotics in the context of acute gastroenteritis.[19] Although our study results support both therapies (Bifidobacterium and Lactobacillus & Saccharomyces) for acute watery diarrhoea, following are major limitations that were observed during course of the study being small sample size, single center and hospital-based study, dietary patterns prevalent in our society, hydration status and the therapies given to children at home prior to reporting to the hospital for treatment.

CONCLUSION

Despite limitations, this study concluded that bacterial probiotics resulted in statistically significant reductions in diarrhoea duration and frequency compared to fungal probiotics among young children. Further studies must be planned at community level in different parts of the country to ensure and find out the effectiveness of suitable treatment options for acute watery diarrhoea in young children.

AUTHORS' CONTRIBUTION

SAS: Topic identification, Data Collection, Referencing. SN: Introduction and Literature Review FJ: Data Collection. MAR: Research methodology, Data analysis. AR: Data entry, data analysis ZK: Discussion.

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