

## Infection Rate and Therapeutic Trials on Various Gastrointestinal Parasites in Sheep and Goats in and Around Lahore, Pakistan

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**Abstract.-** A longitudinal study was conducted to determine the infection rate of gastrointestinal parasites in diarrheic and non-diarrheic sheep and goats along with therapeutic efficacy of different drugs from October, 2010 to October, 2011 in Lahore (Punjab), Pakistan. A total of 480 fecal samples comprising of 240 samples from sheep and 240 from goats were examined to check the presence of gastrointestinal parasitic infection. Out of 240 samples of sheep 173 (72.08%) samples were positive while out of 240 samples of goats 161 (67.08%) samples were positive. Higher infection rate of gastrointestinal parasites among sheep was recorded as compared to goats. While comparing class wise helminthic infection rate, parasites of class Nematoda (46.25% sheep; 44.17% goats) showed top prevalence, followed by Trematoda (20.42% sheep; 18.33% goats) and Cestoda (5.42% sheep; 4.58% goats). The efficacy of levamisol + oxclozanide was observed to be 48, 76 and 88% in sheep, 56, 75 and 90% in goats after 3rd, 7th and 14th day of treatment, respectively. Albendazole proved to be less effective showing 57, 74 and 86% in sheep, 64, 77 and 87% efficacy in goats at 3rd, 7th and 14th day of treatment, respectively. Neem leaf seed powder was least effective against gastrointestinal parasites showing efficacy 16, 31 and 43% in sheep, 15, 23 and 40% in goats on 3rd, 7th and 14th day of treatment, respectively. It was concluded that gastrointestinal helminths in sheep and goats are of considerable significance in Lahore, while levamisol + oxclozanide is the best effective drug against gastrointestinal parasites in both sheep and goats.

**Key words:** Gastrointestinal parasites, infection rate, sheep, goats, neem seed leaf powder.

### INTRODUCTION

Livestock sector contributed almost 55.1% of the agriculture share and 11.6% to GDP of Pakistan during 2011-2012. Livestock plays an important role towards rural economy as 35–40 million rural inhabitants are linked to livestock and deriving 30-40% of the income from livestock. Each household has 2 to 3 cattle or buffaloes and 5 to 6 sheep or goats. Sheep and goats raising have great significance in rural economy mainly for non-agricultural low lying class of people. The sheep and goats population has been estimated about 28.4 and 63.1 million (M), respectively. In Pakistan, 0.816 M tons milk, while 0.629 M tons mutton was yielded by sheep and goats during 2011-2012 for human intake (Anonymous, 2012).

Major health problem in sheep and goats is parasitic infestation (Gadahi *et al.*, 2009). They cause loss of body weight, poor body condition, low birth weights and difficulty in lambing and kidding. The animals become susceptible to other health problems due to parasitic infestation which can lead to death (Pawel *et al.*, 2004; Abouzeid *et al.*, 2010). Low productivity in animals is related to reduction of feed intake, reduced work capacity, retarded growth and expenses of treatment and control of helminthosis (Pedreira *et al.*, 2006; Odoi *et al.*, 2007; Chaudhary *et al.*, 2007).

Anthelmintics chemotherapy is the best way to treat helminth infection, though treatment is expensive and resistance to drugs has developed in all the major parasite species (Veale, 2002). Anthelmintics are also required for the treatment of parasitism in goats. On the other hand, there is a considerable variation in their physiology which means that in goat blood level of active ingredient declines more quickly after treatment than in sheep.

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This thing has the potential to decrease the efficacy of treatment and because of that selection of drug resistant strains of parasites can be much quicker in goats than in sheep (Mortensen *et al.*, 2003).

Considering the utilization and importance of sheep and goats in our country and the substantial losses due to the GIT parasites, the present project was designed to study infection rate and therapeutic trials on various GIT parasites in sheep and goats in and around Lahore, Pakistan.

## MATERIALS AND METHODS

### *Sources of samples*

A total of 480 small animals (240 sheep; 240 goats) presented at the University's outdoor clinic in the medicine section, from the territory of Lahore for the presence of helminths during October, 2010 to October, 2011, were included in this study.

### *Collection of fecal samples*

Fecal sample (5g) were collected directly from rectum of 240 sheep and 240 goats in clean polythene bags, then labeled and refrigerated till further processing. These samples were categorized into three groups *viz.*, normal (80), semisolid (80) and diarrheic (80) according to their consistency.

### *Analysis of fecal samples*

In all the fecal samples the presence of eggs of helminths were analyzed through direct smear and salt flotation technique. By using Mac-Master technique eggs per gram (EPG) were counted while the different ova of helminths were identified by using key as mentioned by Soulsby (1982).

### *Clinical trials*

Out of 480 animals, sixty animals (30 sheep; 30 goats) positive for GIT parasites were randomly divided into three groups *viz.*, A, B and C and each group comprised of 20 animals (10 sheep, 10 goats). The animals of group A were treated with levamisole + oxclozanide @ 5.5-11mg/kg orally; the animal of group B were treated with albendazole @ 10-15 mg/kg orally, while the animals of group C were treated with dry neem (*Azadirachta indica*) leaf powder @ 2 teaspoon (5-10g). EPG values of the animals was counted at day 0 (pre-treatment) and

day 3, 7, 14 (post-treatment) by using Mac-Master technique, while the efficacy of drugs was calculated as per formula of Varady *et al.* (2004).

$$[\text{Pretreatment EPG} - \text{Post treatment EPG} / \text{Pretreatment EPG}] * 100$$

### *Statistical analysis*

The data on the prevalence of helminths was estimated by Pearson's chi-square test, whereas data on therapeutic trials was analyzed with one way ANOVA using Statistical Package for the Social Sciences (SPSS).

## RESULTS AND DISCUSSION

The results on the prevalence of various gastrointestinal parasites in sheep and goats are given in Table I. Results showed an overall 72.08% (173) infection rate in sheep which is in agreement with the findings of Raza *et al.* (2007), Asif *et al.* (2008), Ijaz *et al.* (2009) and Zeryehun (2012) who reported infection rate of helminths 62%, 72%, 70.67% and 67.75% in sheep, respectively but higher than findings of Sultan *et al.* (2010), who reported 51.9% of helminths infection in sheep in Egypt. In goats, infection rate was 67.08% (161) which is congruence with Asif *et al.* (2008) and Ijaz *et al.* (2008) who reported infection rate of 63.69% and 63.33% helminthes, respectively in goats in the present study area but it is higher than that reported by Raza *et al.* (2007) and Zeryehun (2012) who reported 52% in Southern Punjab and 55.47% in Ethiopia, respectively. The infection rate of GIT parasites varies in different parts of world. There are number of factors such as level of economic capacity of farmers, education of the farmers, grazing habits of animals, standard of management and anthelmintics used which can cause fluctuation of the infection rate of GIT parasites. Prevailing agro-climatic conditions like overstocking, grazing of young and adult animals together supply an ideal condition for the transmission of GIT parasites and raise infestation of the endoparasites (Gadahi *et al.*, 2009). In present study infection rate was higher in sheep compared to goats. Similar results were reported by Waruiru *et al.* (2005) and Asif *et al.* (2008) in Rawalpindi and Islamabad, Pakistan and Zeryehun (2012) in Ethiopia. Different species of

**Table I.- Infection rate of gastrointestinal parasites in sheep and goats.**

Sample Nature Parasites spp.	Normal sample (n=80)		Semi solid sample (n=80)		Diarrheic sample (n=80)		Total infection rate (Positive animals) n=240
	Positive samples	Infection rate (%)	Positive samples	Infection rate (%)	Positive samples	Infection rate (%)	
<b>A) Sheep</b>							
<b>Nematodes</b>							
<i>Haemonchus contortus</i>	14	17.5	23	28.75	34	42.5	29.58% (71)
<i>Stroggylis pappilosis</i>	4	5.	6	7.5	8	10	7.50% (18)
<i>Trichostrongylus spp.</i>	3	3.75	4	5	6	7.5	5.42% (13)
<i>Trichuris globulosa</i>	2	2.5	3	3.75	4	5	3.75% (09)
<b>Trematodes</b>							
<i>Fasciola</i>	20	25	12	15	4	5	15.00% (36)
<i>Dicrocoelium</i>	8	10	4	5	1	1.25	5.42% (13)
<b>Cestodes</b>							
<i>Monezia</i>	2	2.5	7	8.75	4	5	5.42%(13)
<b>B) Goats</b>							
<b>Nematodes</b>							
<i>Haemonchus contortus</i>	14	17.50	21	26.25	31	38.75	27.50% (66)
<i>Stroggylis pappilosis</i>	5	6.25	7	8.75	9	11.25	8.75% (21)
<i>Trichostrongylus spp.</i>	2	2.50	3	3.75	4	5.00	3.75% (09)
<i>Trichuris globulosa</i>	2	2.50	3	3.75	5	6.25	4.17% (10)
<b>Trematodes</b>							
<i>Fasciola</i>	13	16.25	10	12.50	6	7.50	12.08% (29)
<i>Dicrocoelium</i>	7	8.75	6	7.50	2	2.50	6.25% (15)
<b>Cestodes</b>							
<i>Monezia</i>	2	2.50	6	7.50	3	3.75	4.58%(11)

GIT parasites recovered in this study were *Haemonchus contortus*, *Strongylis pappilosis*, *Trichostrongylus*, *Trichuris globulosa*, *Fasciola*, *Dicrocoelium* and *Monezia*, which were also reported by Asif *et al.* (2008) and Zeryehun (2012). Nematode infection rate was more prevalent followed by that of trematodes and cestodes in both sheep and goats. There were 111 (46.25%), 49(20.42%) and 13(5.42%) positive samples in sheep, while 106(44.17%), 44(18.33%) and 11(4.58%) positive samples in goats for nematodes, trematode and cestodes respectively. These findings are similar to those of Ijaz *et al.* (2008, 2009) in the same study area. Among nematodes *Haemonchus contortus*, *Strongylis pappilosis*, *Trichostrongylus* and *Trichuris globulosa* infection rate was 29.58, 7.50, 5.42 and 3.75% in sheep and 27.50, 8.75, 3.75 and 4.17% in goats, respectively. In these results *Haemonchus contortus* infection was more, Jacquet

*et al.* (1992) and Ijaz *et al.* (2008, 2009) also reported higher prevalence of *Haemonchus contortus* in sheep and goats, which may be due to development of resistance compared to others because of its more biotic potential like *Trichostrongylus* (Torres-Acosta *et al.*, 2003). However, *Haemonchus contortus* was more prevalent which in sheep compared to goats, may be due to grazing behavior and less cleanliness in goats (Javed *et al.*, 1992). In this study trematodes infection was 20.42% in sheep and 18.33% in goats. Among trematode *Fasciola* and *Dicrocoelium* infection rate was 15 and 5.42% in sheep, while 12.08 and 6.25% in goats, respectively. *Monezia* infection was lower in both species, it was 5.42 and 4.58% in sheep and goat, respectively. *Monezia* + *H. contortus* infection was 3.33 and 3.75% in sheep and goats while *Monezia* + *Strongylis* infection was 0.83 and 0.83% in sheep and goat, respectively.

### Mixed infections

In present study mixed infection of *Monezia*, *H. contortus*, *Strongylus* and *Fasciola* is 10.83 and 11.25% in sheep and goats, respectively (Table II). Zeryehun (2012) also reported an overall 11.32% mixed infection in sheep and goats. Maichomo *et al.* (2004) described that mostly animals were infected with one or two species of parasites and show multiple signs like diarrhea, anorexia, anemia, loss of weight, pale mucous membranes, edema, dehydration, lethargy and death. In tropical and temperate climates *Coccidia* and other GIT parasites are major cause of single or mixed parasitic infections in sheep and goats (Faizala and Rajapakseb, 2001).

### Therapeutic trials in sheep

Efficacy of levamisol + oxyclozanide, albendazole and neem leaves against various GIT parasites in sheep are shown in Tables III and IV. Group A was treated with levamisol + oxyclozanide and its efficacy was 48, 76 and 88% on day 3, 7 and 14, respectively. In group B albendazole efficacy was 57, 74 and 86% on 3rd, 7th and 14th day, respectively. The efficacy of neem leaves efficacy was 16, 31 and 43% on day 3rd, 7th and 14th, respectively. The efficacy of levamisol + oxyclozanide and albendazole was significantly higher ( $p=0.000$ ) than that of neem leaves. Ram *et al.* (2007) reported albendazole 14% effective, followed by its combination with rafoxanide 54% in Pashmina goats infected with *Haemonchus* spp. and kept at high altitude. These findings do not correlate with the results of the current study. The basis may be the drug resistance of parasites aligned with albendazole in the study area. Efficacy of closantel, albendazole and levamisole on an ivermectin resistant strain of *Haemonchus contortus* in sheep was studied by Waruiru (1997) and was declared that all the anthelmintics resulted in decreased worm load in animals infected with the susceptible strain (albendazole, 99.0%). Anthelmintic activity of neem was conducted on round worm of sheep by Chandrawathani *et al.* (2006). The total worm count was made by slaughtering all the animals and results indicated that no significant difference of FEC between the control group and treated group value

while worm load was highly significantly in the control group compared to the treated group. The result showed that feeding neem had significant effect on worm numbers in sheep, but did not significantly decreased FEC. The minor difference of efficacies between oxyclozanide and albendazole may be due to the fact that albendazole is most commonly used drug compared to oxyclozanide and there is chance of drug resistance. Coles and Stafford (2001) also reported that efficacy of oxyclozanide was maximum 99.6% in sheep. This showed that oxyclozanide is best drug for the treatment of GIT parasite.

### Therapeutic trials in goats

Data regarding the efficacy of levamisol + oxyclozanide, albendazole and neem leaves in goats are shown in Tables III and IV. Group A was treated with levamisol + oxyclozanide and its efficacy was 56, 75 and 90% at day 3rd, 7th and 14<sup>th</sup>, respectively. In group B albendazole efficacy was 64, 77 and 87% on 3rd, 7th and 14th day respectively. The efficacy of neem leaves was 15, 23 and 40% on 3rd, 7th and 14th day, respectively. The efficacy of levamisol + oxyclozanide and albendazole was significantly higher ( $p=0.000$ ) than that of neem leaves. When compared on different days as well as group wise, levamisol+oxyclozanide reduced the EPG significantly, followed by albendazole and neem leaves. Chandrawathani *et al.* (2006) counted the mean FEC of the control and neem treated groups remained almost the same until day 11. However, from day 12 onwards, the neem treated group had lower FEC compared to the control group but these differences were not significant. Waruiru (1997) also reported that albendazole, closantel and levamisole remarkably decreased the worm load in infected animals with GIT helminths. These results are in close alignment with the results of current study. Likewise, Ram *et al.* (2007) reported the efficacy of albendazole plus rafoxanide combination as 54%, which is not in accordance to our results. This is due to development of drug resistance against these drugs in that area. Paraud *et al.* (2009) also reported that the efficacy of oxyclozanide was 96% in goat and concluded that oxyclozanide is highly effective in reducing the number of rumen flukes.

**Table II.- Mixed infection rate of gastrointestinal parasites in sheep and goats.**

Parasites	Sheep (n=240)		Goats (n=240)	
	Positive samples	Infection rate (%)	Positive samples	Infection rate (%)
<i>Monezia</i> + <i>H. contortus</i>	8	3.33	9	3.75
<i>Monezia</i> + <i>Strongylis</i>	2	0.83	2	0.83
<i>Fasciola</i> + <i>Strongylis</i>	2	0.83	6	2.50
<i>H. contortus</i> + <i>Strongylis</i>	14	5.83	10	4.17
Total	26	10.83	27	11.25

**Table III.- EPG values of gastrointestinal parasites in sheep and goats.**

Drugs	Animals.	EPG values at various days after treatment			
		0day	3 <sup>rd</sup> day	7 <sup>th</sup> day	14 <sup>th</sup> day
Levamisol + oxcyclozanide	Sheep	205±10.823	106±7.067	49±16.990	25±6.948
	Goat	216±5.466	96 ± 5.884	55 ±5.755	22± 5.621
Albendazole	Sheep	234±7.633	101±9.214	61±8.832	32±6.373
	Goat	194±7.020	70 ±5.295	45± 6.208	26 ± 8.862
Neem leaves ( <i>Azadirachta indica</i> )	Sheep	134±7.273	113±7.229	92±8.342	76±5.270
	Goat	181±9.440	154±5.506	140±9.012	109±6.720

(P- value= 0.000, df = 2, □ □ highly significant, □ significant, ±SD)

**Table IV.- Efficacy of various drugs against gastrointestinal parasites in sheep and goats**

Drugs	Animal spp.	Efficacy at various days after treatment (%)		
		3 <sup>rd</sup> day	7 <sup>th</sup> day	14 <sup>th</sup> day
Levamisol + oxcyclozanide	Sheep	48	76	88
	Goat	56	75	90
Albendazole	Sheep	57	74	86
	Goat	64	77	87
Neem leaves ( <i>Azadirachta indica</i> )	Sheep	16	31	43
	Goat	15	23	40

(P-value= 0.000, df = 2, □ □ highly significant, □ significant)

## CONCLUSIONS

Form this study it is concluded the most effective drug is combination of levamisole + oxcyclozanide against helminths of sheep and goats compared to albendazole and neem leaves.

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## REFERENCES

- ABOUZEID, N.Z., SELIM, A.M. AND EL-HADY, K.M., 2010. Prevalence of gastrointestinal parasites infections in sheep in the Zoo garden and Sinai district and study the efficacy of anthelmintic drugs in the treatment of these parasites. *J. Anim. Sci.*, **6**: 544-551.
- ANONYMOUS, 2012. *Economic survey of Pakistan*. Finance division, economic advisors wing, ministry of finance, government of Pakistan, Islamabad.
- ASIF, M., AZEEM, S., ASIF, S. AND NAZIR, S., 2008. Prevalence of gastrointestinal parasites of sheep and goats in and around Rawalpindi and Islamabad. Pakistan. *J. Vet. Anim. Sci.*, **1**: 14-17.
- CHANDRAWATHANI, P., CHANG, K.W., NURULAINI, R.,

- WALLER, P.J., ADNAN, M., ZAINI, C.M., JAMNAH, O., KHADJAH, S. AND VINCENT, N., 2006. Daily feeding of fresh Neem leaves (*Azadirachta indica*) for worm control in sheep. *Trop. Biomed.*, **23**: 23–30.
- CHAUDHARY, F.R., KHAN, M.F.U. AND QAYYUM, M., 2007. Prevalence of *Haemonchus contortus* in naturally infected small ruminants grazing in the Photohar area of Pakistan. *Pakistan Vet. J.*, **27**: 73–79.
- COLES, G.C. AND STAFFORD, K.A., 2001. Activity of oxyclozanide, nitroxylin, clorsulon and albendazole against adult triclobandazole resistant *Fasciola hepatica*. *Vet. Rec.*, **148**: 723–724.
- FAIZALA, A.C.M. AND RAJAPAKSEB, R.P.V.J., 2001. Prevalence of coccidia and gastrointestinal nematode infections in cross bred goats in the dry areas of Sri Lanka. *Small Rumin. Res.*, **40**: 233–238.
- GADAH, J.A., ARSHED, M.J., ALI, Q., JAVAID, S.B. AND SHAH, S.I., 2009. Prevalence of gastrointestinal parasites of sheep and goats in and around Rawalpindi and Islamabad. *Pakistan. Vet. World*, **2**: 51–53.
- IJAZ, M., KHAN, M.S., AVAIS, M., ASHRAF, K., ALI, M.M. AND KHAN, M.Z.U., 2009. Infection rate and chemotherapy of various helminths in diarrheic sheep in and around Lahore. *J. Anim. Pl. Sci.*, **19**: 13–16.
- IJAZ, M., KHAN, M.S., AVAIS, M., ASHRAF, K., ALI, M.M. AND SAIMA, 2008. Infection rate and chemotherapy of various helminths in goats in and around Lahore. *Pakistan Vet. J.*, **28**: 167–170.
- JACQUIET, P., CABARET, J., COLAS, F., DIA, M.L., CHEIKH, D. AND THIAM, A., 1992. Helminths of sheep and goats in desert areas of south-west Mauritania (Trarza). *Vet. Res. Commun.*, **16**: 437–444.
- JAVED, M.S., IQBAL, Z. AND HAYAT, B., 1992. Prevalence and economics of haemonchosis in sheep and goats. *Pakistan Vet. J.*, **12**: 36–38.
- MAICHOMO, M.W., KAGIRA, J.M. AND WALKER, T., 2004. The point prevalence of gastro-intestinal parasitism calves, sheep and goats in Magadi division, south-western Kenya. *Onderstepoort J. Vet. Res.*, **71**: 257–261.
- MORTENSEN, L.L., WILLIAMSON, L.H., TERRILL, T.H., KIRCHER, R.A., LARSEN, M. AND KAPLAN, R.M., 2003. Evaluation of prevalence and clinical implications of anthelmintic resistance in gastrointestinal nematodes in goats. *J. Am. Vet. med. Assoc.*, **223**: 495–506.
- ODOI, A., GATHUMA, J.M., GACHUIRI, C.K. AND OMORE, A., 2007. Risk factors of gastrointestinal nematode parasite infections in small ruminants kept in smallholder mixed farms in Kenya. *BMC Vet. Res.*, **3**: 1186–1746.
- PARAUD, C., GAUDIN, C., PORS, I. AND CHARTIER, C., 2009. Efficacy of oxyclozanide against the rumen fluke *Calicophoron daubneyi* in experimentally infected goats. *Vet. J.*, **180**: 265–7.
- PAWEL, G., NIZNIKOWSKI, R., STRZELEC, E., POPIELARCZYK, D., GAJEWSKA, A. AND WEDRYCHOWTCZ, H., 2004. Prevalence of protozoan and helminth internal parasite infections in goat and sheep flocks in Poland. *Arch. Tierz. Dummerstorf.*, **47**: 43–49.
- PEDREIRA, J., SILVA, A.P., ANDRADE, R.S., SUAREZ, J.L., ARIAS, M., LOMBA, C., DIAZ, P., LOPEZ, C., BANOS, P.D. AND MORRONGO, P., 2006. Prevalence of gastrointestinal parasites in sheep and parasite control practices in North-West Spain. *Prev. Vet. Med.*, **75**: 56–62.
- RAM, H., RASOOL, T.J., SHARMA, A.K., MEENA, H.R. AND SINGH, S.K., 2007. Comparative efficacy of different anthelmintics against fenbendazole-resistant nematodes of pashmina goats. *Vet. Res. Commun.*, **31**: 719–723.
- RAZA, M.A., IQBAL, Z., JABBAR, A. AND YASEEN, M., 2007. Point prevalence of gastrointestinal helminthiasis in ruminants in southern Punjab, Pakistan. *J. Helminthol.*, **81**: 323–328.
- SOULSBY, E.J.L., 1982. *Helminths, arthropods and protozoa of domesticated animals*, 7th Ed. Bailliere Tindall, London U.K, pp. 579–624, 765–766.
- SULTAN, K., DESOUKEY, A.Y., ELSIEFY, M.A. AND ELBAHY, N.M., 2010. An abattoir study on the prevalence of some gastrointestinal helminths of sheep in Gharbia Governorate, Egypt. *Glob. Vet.*, **5**: 84–87.
- TORRES-ACOSTA, J.F.J., DZUL-CANCHE, U., CABALLERO, A.J.A. AND VIVAS, R.I.R., 2003. Prevalence of benzimidazole resistant nematodes in sheep flocks in Yucatan, Mexico. *Vet. Parasitol.*, **114**: 33–42.
- VARADY, M., KONIGOVA, A. AND CORBA, J., 2004. A field study to evaluate the efficacy of fenbendazole on 9 stud farms. *Vet. Med. Czech.*, **49**: 42–46.
- VEALE, P.I., 2002. Resistance to macrocyclic lactones in nematodes of goats. *Aust. Vet. J.*, **80**: 303–304.
- WARUIRU, R.M., 1997. Efficacy of closantel, albendazole and levamisole on an ivermectin resistant strain of *Haemonchus contortus* in sheep. *Vet. Parasitol.*, **73**: 65–71.
- WARUIRU, R.M., MUTUNE, M.N. AND OTIENO, R.O., 2005. Gastrointestinal parasite infections of sheep and goats in a semi-arid area of Machakos district, Kenya. *Bull. Anim. Hlth. Prod. Afr.*, **53**: 25–34.
- ZERYEHUN, T., 2012. Helminthosis of sheep and goats in and around Haramaya, Southeastern Ethiopia. *J. Vet. Med. Anim. Hlth.*, **4**: 48–55.

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