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Nitrate Contamination in the Groundwater of Ramannapet mandal Yadhadri Bhuvangiri District, Telangana, India.

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***Abstract* - Groundwater forms the major source of drinking water in the rural areas of most of the developing nations of the world. Presence of high concentration of nitrate in groundwater is a major problem in many countries as it causes health related problems. The present study is carried out to understand the distribution of nitrate concentration in groundwater in parts of Ramannapet mandal Yadhadri Bhuvangiri District, Telangana, India. Though groundwater is the major drinking water source, deterioration in its quality is going unchecked. In rural areas, the nitrate contamination is uncontrolled and much attention has not been drawn towards this anthropogenic pollution.**

In the study area 37 groundwater samples have been collected and analyzed for the major ions such as Electrical Conductivity (EC), pH, Total Dissolved Solids (TDS), Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, CO_3^-, SO_4^-, NO_3^- and F^-. The study revealed that 39% of the samples were found to be unsuitable for drinking purposes due to excess nitrate (>45 mg/l) content in the groundwater. High Nitrate concentration may cause blue baby syndrome or methemoglobinemia.

***Index Terms* - Groundwater, Nitrate, Contamination, Kalwakurthy, Mahabubnagar District.**

INTRODUCTION

Water is one of the most essential requirements of all living beings. For a long time, groundwater has been considered as a well protected resource. The reason for this was the belief in self purification of the soil and as a rule the protection of groundwater by the covering layers. Man's influence on the quality of water is quite apparent and now a major concern. Groundwater has to be protected generally as it forms a principal source for drinking water and as it represents also a precious ecological part within the balance of water cycle

Nitrogen, an element considered to be the most abundant in the atmosphere, composing nearly 80% [1], can be found in many forms, the major ones being N_2, N_2O, NO, NO_2, NH_3 [2]. Nitrate is part of the nitrogen cycle in nature and it represents the most oxidized chemical form of nitrogen found in the natural systems. All living systems need nitrogen for their existence since it is used to build many essential components such as proteins, DNA, RNA, vitamins, and as well as hormones and enzymes. Nitrates, though very essential for the very existence of life, is also one of the most widespread pollutants of groundwater in many parts of the world and in several instances this is due to the intensification of agriculture [3].

Nitrate is a common surface water and groundwater contaminant that can cause health problems in infants and animals, as well as the eutrophication of water bodies [4]. As the geological sources of nitrogen are very rare, the presence of nitrate in groundwater is mostly due to anthropogenic activities. Nitrate when present in high levels would cause methemoglobinemia where they bind with the red blood cells and reduce their ability to carry oxygen. The consumption of nitrate rich water cause a large number of diseases like dizziness, abdominal disorder, vomiting, weaknesses, high rate of palpitation, mental disorder and even stomach cancer etc [5-8]. Consumption of drinking water with nitrate, at concentrations greater than 50 mg/l causes Blue baby syndrome, a disease where the skin becomes blue due to decreased efficiency of hemoglobin to carry the oxygen [9]. This phenomenon can occur in infants when approximately 70% of total hemoglobin has been converted to methemoglobin [10]. As the groundwater is at a constant threat of being polluted because of natural and anthropogenic sources, the present study is carried out to understand the distribution of these ions and their probable sources. As the groundwater is at a constant threat of being polluted because of natural and anthropogenic sources, the present study is carried out to understand the distribution of these ions and their probable sources.

STUDY AREA

The study area covering about 228 sq. Km falls in Yadhadri Bhuvangiri District, Telangana, is located in the Northern Part of the District and is bounded on the North by Mothkur and Valigonda, East by Narketpalli, South by Chityala mandal, and West by Choutuppal Mandal. The elevation of the study area varies from 255m to 370m MSL. (figure 1) and The study area is 75 km from the Telangana capital Hyderabad and 37 km from district headquarter. The study area in Ramannapet mandal of Yadadri - Bhuvanagiri district is lies in between 17º14’14’’ and 17º22’22” of north latitudes and 78º59’17” and 79º15’12” of east longitude.

GEOLOGY

Stratistographically, the area is mainly exposed to rocks of the Peninsular Gneissic Complex (PGC) with basic dykes (proterozoic). PGC consists of two types, the older granite gneiss types and the smaller granite - alkali feldspar granite is widely distributed throughout the region. (Fig.2) these rocks are composed of quartz, feldspars, and biotite. These are medium to course grained and equigranular in texture. The typical grey colour is due to the presence of the plagioclase feldspars and quartz. The potash feldspars that are present in the rock are orthoclase and microcline but in less abundance. Biotite is the most predominant mineral in these rocks.

MATERIALS AND METHODS

In order to assess the groundwater quality, 37 groundwater samples have been collected. The water samples collected in the field were analyzed for electrical conductivity (EC), pH, total dissolved solids (TDS), Total Hardness (TH), major cations like calcium, magnesium, sodium, potassium and anions like bicarbonate, carbonate, chloride, nitrate and sulphate, trace element like fluoride in the laboratory using the standard methods given by the American Public Health Association [12]. Sampling was carried out using pre-cleaned polyethylene containers. The results were evaluated in accordance with the drinking water quality standards given by the (WHO, 2004) and (Bureau of Indian Standards) [13]

The pH was measured with Digital pH Meter (Model 802 Systronics) and EC was measured with Conductivity Meter (Model 304 Systronics), Sodium and Potassium was measured with Flame photometer (Model Systronics 130). Sulphates and Nitrates were measured with Spectronics 21 (Model BAUSCH & LOMB), Carbonate, Bicarbonate, Calcium, Magnesium, Total Dissolved Solids, Total Hardness, and Chloride by titrimetric methods, Fluoride concentration was measured with Orion ion analyzer with fluoride ion selective electrode. Nitrate was determined by spectrophotometer. The concentration of EC is expressed in μS/cm at 25ºC and TDS, TH, Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, $C1^{-}$, SO_4^{-}, NO_3^{-}, CO_3^{-}, HCO_3^{-} and F^{-} are expressed in mg /l. Location map of the water sample is shown in the (Fig.1). The analytical results are presented in Tables 1. The concentrations are compared with the standards (WHO, 2004; BIS, 2009) and the statistical parameters of the variables such as minimum, maximum mean of different chemical parameters of groundwater are given in Table 2. Distribution map is generated for Nitrate with the help of GIS software to know the spatial distribution of the concentrations Fig (2).

RESULTS AND DISCUSSION

The pH and Electrical Conductivity (EC) values of the study area are ranging from 7.42 to 8.8 and 78.44 to 600-5700μ S/cm, respectively. In the study area, the Na^{+} and K^{+} concentrations are in groundwater ranging from 12-168 and 1-8mg/L, respectively. The concentrations of calcium ranging from 38-186mg/L. The concentrations of Mg^{++} and HCO_3^{-} ions found in the groundwater samples of study area are ranging from 5-134 and 54-232mg/L respectively. The concentration of chloride ranging from 32-861mg/L. Sulfate ranging from 22-182mg/L. The concentration of fluoride in groundwater of the study area varies between 0.44-5.67 mg/L.

NITRATE (NO_3)

Chemical analysis of nitrate shows that the concentration was higher in 18 samples which are total of 48% samples (BIS, 2009). The concentration of Nitrate was ranging from 8-169mg/L with an average value of 49.51 mg/L. From fig. 2, it is clear that the value of nitrate concentration is found maximum in sample R13 (106 mg/l), followed by R14 (100 mg/l) and R35 (101mg/l) representing the drinking waters samples of Bogaram, Kommaigudem and Suraram villages of Ramannapet area and it is observed that the concentration of Nitrate is high in middle and south parts of the area. The main source of this nitrate pollution is attributed to the excessive use of nitrogenous fertilizers, as these areas are mainly agricultural areas. Moreover, plants absorb nitrate fertilizer through roots, which is then transformed into microorganisms [14]. The compensation of nitrate is insignificant in the soil environment [15] and hence nitrate percolates into groundwater.

CONCLUSION

Hydrochemical studies of the Ramannapet area and its environs indicate that the concentration of nitrate is higher than permissible limit (45 mg/l) in most of groundwater collected from wells. The chief sources of nitrate pollution in the study area are agricultural activities, septic tanks, and human and animal wastes. Among the agricultural sources, the common sources are inorganic fertilizer, urea. Septic systems, animal waste, and fertilizer are all potential sources of nitrate contamination. Water that comes into contact with a source of nitrate can carry that contamination through the soil and into the groundwater supply. The appropriate remedial measures should be implemented in order to restore the aquatic ecology of the polluted area.

The most effective way of reducing the nitrogen content of groundwater in the areas where agriculture is the main occupation is to reduce the application of fertilizers in consultation with agriculture scientists and change the cropping pattern by going in for irrigated dry crops which consume less water and fertilizers. It is suggested that frequently modifying the cropping sequences offer possible ways to scavenge the nitrogen and provide fluoride-free drinking water in the study area.

ACKNOWLEDGMENTS

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Table 1: Analytical Data of the Groundwater in the Study Area

S.No	Village	wells	pre monsoon NO_3^-	post mon soon NO_3^-	S.No	Village	wells	pre monsoon NO_3^-	post monsoon NO_3^-
R_01	Vellanki	Bore well	58	68	R_23	Utthatooru	Bore well	10	57
R_02	Vellanki	Bore well	10	90	R_24	Iskilla	Bore well	28	36
R_03	Siripuram	Bore well	98	78	R_25	Munipampula	Dugwell	38	52
R_04	Siripuram	Bore well	10	50	R_26	Munipampula	Dugwell	61	82
R_05	Siripuram	Dugwell	68	88	R_27	Paliwada	Dugwell	32	48
R_06	Thummalagudem	Bore well	58	85	R_28	Paliwada	Dugwell	40	58
R_07	Thummalagudem	Dugwell	14	28	R_29	Iskilla	Bore well	32	69
R_08	Thummalagudem	Bore well	45	68	R_30	Kakkireny	Dugwell	18	28
R_09	Shobanaadhripuram	Bore well	36	48	R_31	Kakkireny	Bore well	16	21
R_10	Nidaanpalli	Bore well	98	96	R_32	Yennaram	Bore well	19	18
R_11	Bogaram	Bore well	65	86	R_33	Yennaram	Dugwell	16	24
R_12	Bogaram	Bore well	38	46	R_34	Bachupala	Dugwell	39	35
R_13	Bogaram	Bore well	106	192	R_35	Suraram	Dugwell	101	211
R_14	Kommaigudem	Bore well	100	119	R_36	B.Thurkapalli	Dugwell	21	28
R_15	Ramannapet	Bore well	65	48	R_37	Kunkudu paamula	Dugwell	19	29
R_16	Nirnemula	Dugwell	86	89					

R_17	Nirnemula	Dugwell	68	97						
R_18	Laxmapur	Dugwell	53	68						
R_19	Laxmapur	Dugwell	56	92						
R_20	Dubbaka	Bore well	52	54						
R_21	Dubbaka	Bore well	72	62						
R_22	Janampally	Dugwell	86	96						

Table 2: Comparison of Results of the Study Area with BIS, WHO Standards

S. No	Parameter	Pre-monsoon	Post-monsoon	WHO (2004)	BIS (2012)
1	pH (pH unit)	6.9-8.78	6.77– 8.4	6.6 - 8.5	6.5 - 8.5
2	EC(µS/cm)	600-5700	531 - 4046	--	--
3	TDS (mg/l)	384-3648	340 – 2590	1500	2000
4	Ca (mg/l)	38-186	38 - 151	75	75
5	Mg (mg/l)	5-134	Dec-77	<30	30-100
6	Na (mg/l)	12-168	22 - 132	<200	--
7	K (mg/l)	01-Aug	1 – 6	10	--
8	HCO3	54-232	52-256		500
9	Cl (mg/l)	32-861	66-568	250	250-1000
10	SO 4 (mg/l)	5-102	22-182	200	200-400
11	NO3 (mg/l)	8-169	8-121	50	45
12	F (mg/l)	0.44-5.67	0.26 – 4.56	1.5	1

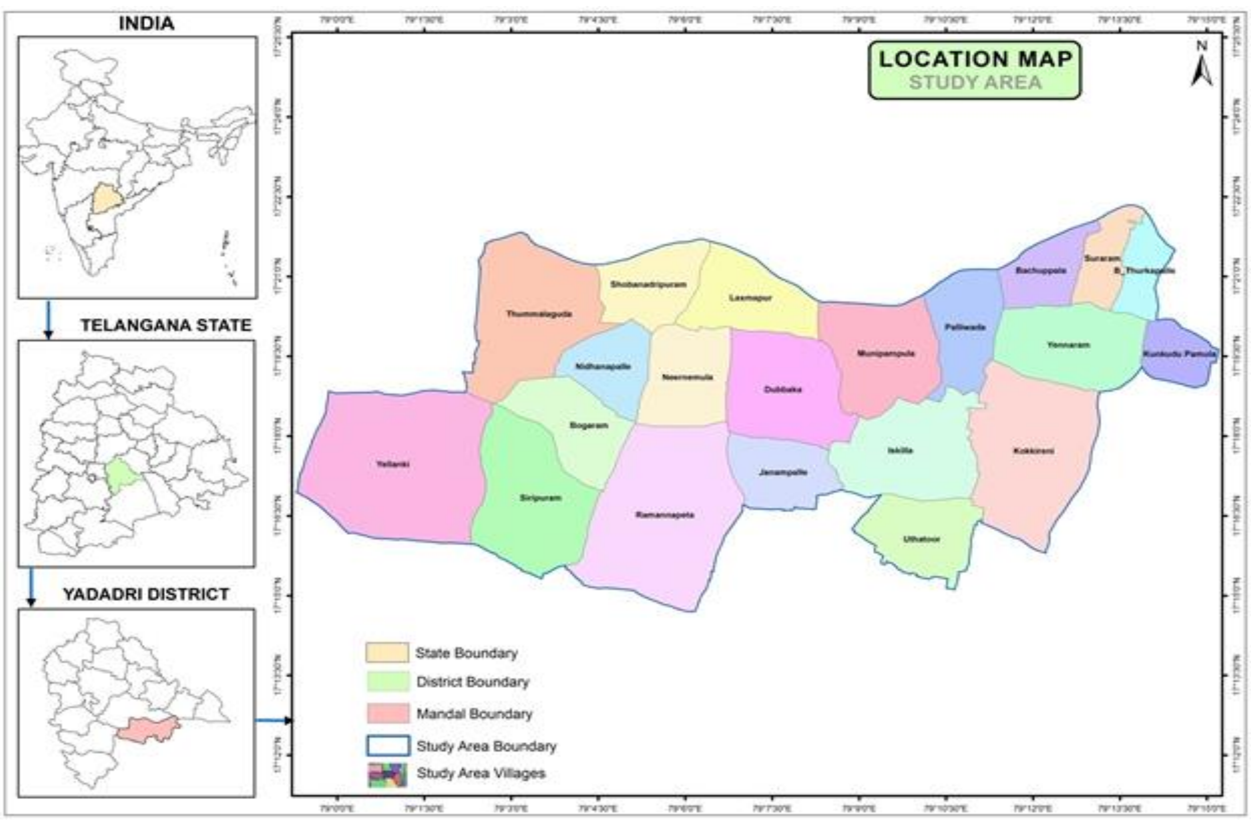

Fig 1. Location Map of the Study Area

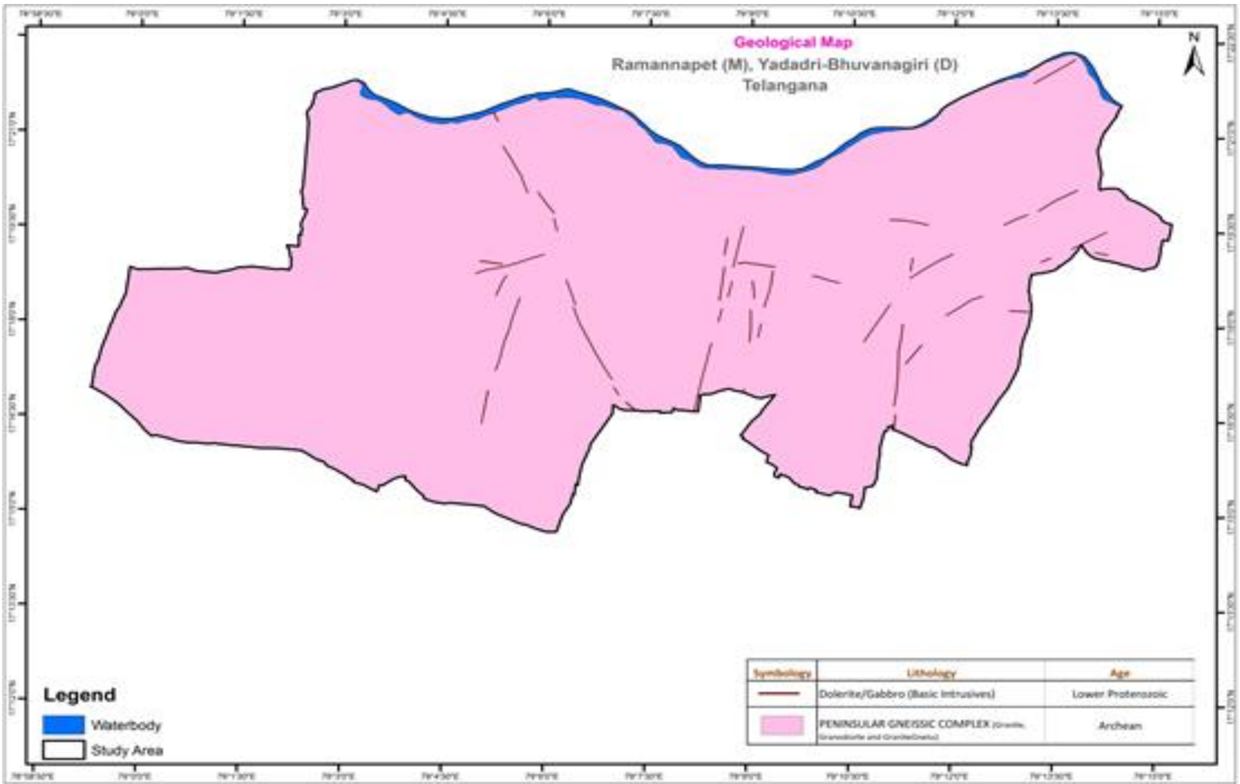

Fig 2: Geological Map of the Study Area

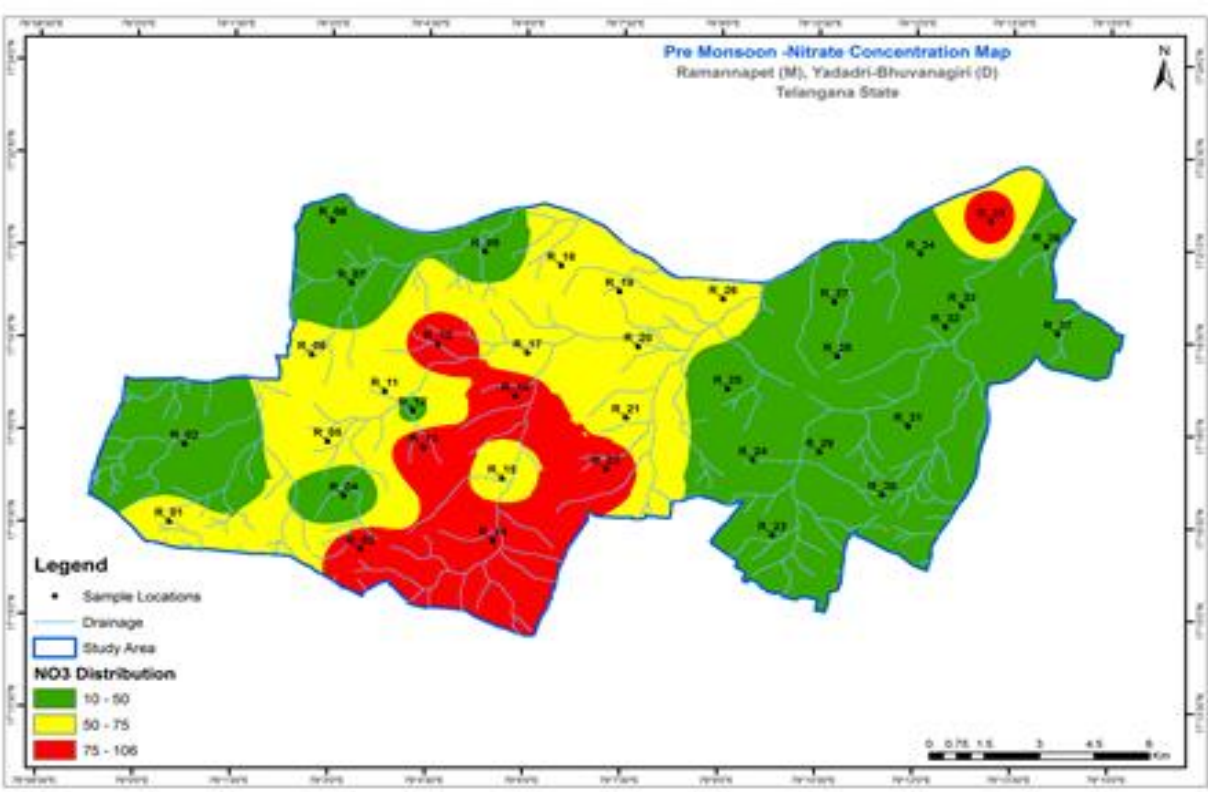

Fig 3a.Map Showing Distribution Pattern of Nitrate (NO_3^-) in pre monsoon

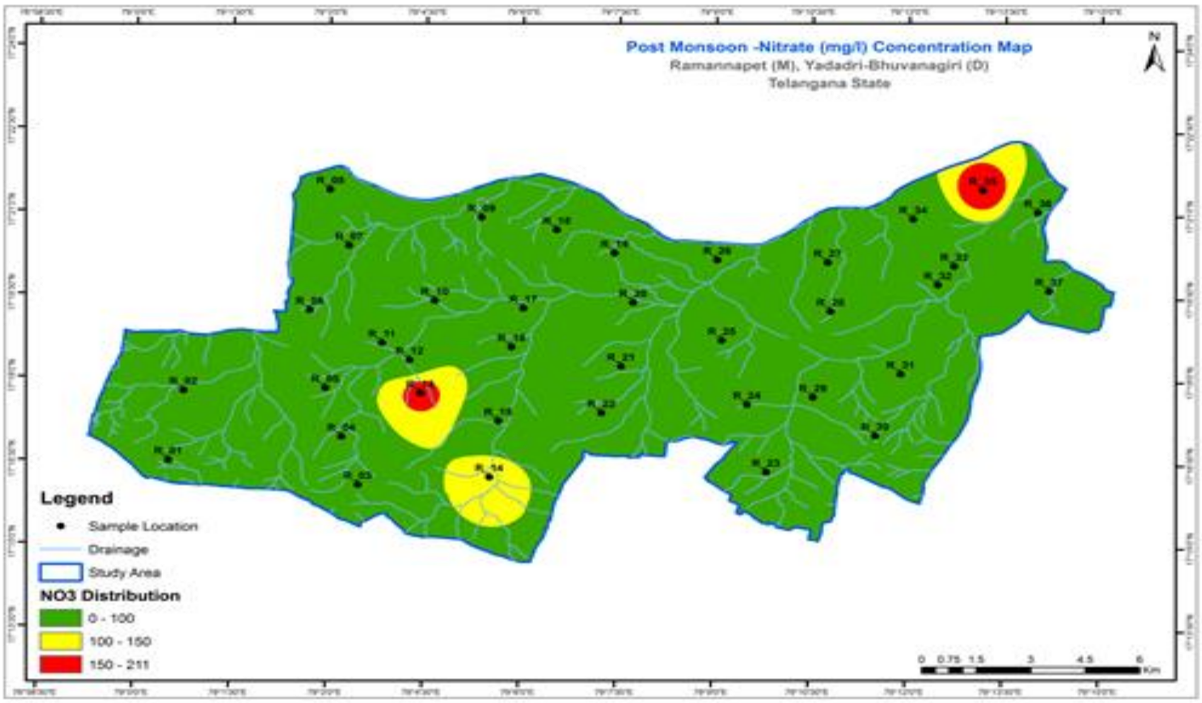

Fig 3b. Map Showing Distribution Pattern of Nitrate (NO_3^-) in pre monsoon

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