

MACRO AND MICRO NUTRIENTS IN SRI LANKAN BLACK TEA AND TEA BREW

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The macro and micro nutrients in eight different Sri Lankan black teas and tea brews were determined. Tea brew was prepared by four different methods. Black tea is rich in many nutrients i.e. potassium (K), magnesium (Mg), iron (Fe), manganese (Mn) and aluminium (Al). Tea brew is a valuable source of K, Mg and Mn for the human diet. No toxic metals such as lead passed into tea liquor during brewing. When the brewing time was increased from 5 to 10 min slightly more nutrients were extracted into the liquor.

INTRODUCTION

Tea is the most popular beverage in the world enjoying continued acceptability as no harmful properties have been associated with tea. While tea brews have marginally nutritive properties numerous pharmacological effects are also claimed for tea. The main constituents of black tea are (a) organic fractions consisting of carbohydrates, caffeine, proteins, lipids and vitamins and (b) inorganic fractions consisting of minerals and salts. The human body needs both macro (K, P, Mg, Ca and S) and micro elements (Cu, Fe, I, F, Mn, Co, Zn and Se) for its healthy functions. Caffeine content in black tea is about 3-4 % and is responsible for the stimulating properties of tea; further, it has a diuretic effect on the kidneys and relieves mental fatigue (Wickremasinghe, 1978). The daily consumption of tea by an adult is about 4-6 cups of 150 ml volume. This supplements the mineral requirements of the human body to a certain extent. The type and quantity of organic fractions present in black tea has been reported (Roberts, 1963; Wickremasinghe, 1978).

There is not much information available on the mineral nutrient value of black tea and tea brew. In this study an attempt has been made to quantify the amount of various mineral (macro and micro) elements present in black tea and tea brew and to examine its importance to human health.

MATERIALS AND METHODS

For this study black tea samples, BOPF, Pekoe, BOP, Fannings, BM, dust No. 1, dust ordinary, ungraded, refuse tea and tea fluff from St Coombs estate situated at an elevation of 1382 m amsl were used.

Determination of nutrient content in tea brew

A standard amount of tea and water was used for the brew (2.5 g in 125 ml water). Tea was infused for 5 and 10 min and the supernatant liquor was filtered from the

infused leaf into a pyrex conical flask. The tea brews were prepared by the following methods:

1. Distilled water boiled in pyrex breaker and brewed in pyrex conical flask.
2. Tap water boiled in pyrex beakers and brewed in pyrex conical flask.
3. Distilled water boiled in aluminium kettle and brewed in pyrex conical flask.
4. Tap water boiled in aluminium kettle and brewed in pyrex conical flask.

Tea brew (20 ml) was placed in a 50 ml pyrex beaker and dried completely on a water bath and then ashed in a muffle for 6 h at 460° C. The ashed content was dissolved in 0.5 ml of digestion mixture (1: 1: 2: HCl: HNO₃ : H₂O) and dried again.

After drying, 10 ml of 0.05 M HCl was added to the above and transferred to a 50 ml volumetric flask with distilled water and made up to the mark. Suitable aliquots were used to determine K, Mg, Ca, Mn, Zn, Cu and Fe, by flame photometer and atomic absorption spectrophotometer. P in the tea brew was determined by the Vanadomolybdate method and Al by the aluminon method. The nitrogen content was determined by the kjeldhal method using 10 ml of the tea brew. The pH of the tea brew was also determined.

Total nutrient content in black tea

All the above elements were also determined in black tea using 0.2 g for dry ashing.

RESULTS AND DISCUSSION

The total nutrient content in different grades of made tea is given in Table 1. In made tea nitrogen content varied from 3.34 to 4.66%. Refuse tea (spent tea) has the lowest nitrogen. In all grades of tea used phosphorus, potassium and magnesium content did not vary much while refuse tea and tea fluff had lower amounts of these nutrients. Aluminium content of these grades of tea were reported elsewhere (Ananthacumaraswamy and Sivapalan, 1990).

Copper content in buds is higher than the leaves, whilst the stalk contains the lowest amount (Ramaswamy, 1960). This trend is clearly seen in the various grades of tea: The fannings grade which contains more buds and less stalk shows the highest amount of copper (31 ppm); BM which has more stalk has the lowest (18 ppm). During tea manufacture the copper content of made tea increases slightly because of contamination from the fittings (Ramaswamy, 1960). Table 2 shows the hot water extractable nutrients in made tea (distilled water 5 min pyrex brew). It can be seen from Table 2 that potassium (ranging from 72-86% of the total element), magnesium (ranging from 46-58%) and zinc (ranging from 46-66%) were the most abundant elements transferred to hot water from made tea samples. This shows that K and Mg complexes are more water soluble than the other elements complexed. However, in the case of phosphorus, manganese and copper only 13-40%, 26-42% and 29-50% of the total elements respectively were transferred to hot water implying that these complexes are not easily soluble in hot water.

TABLE 1 – *Total nutrients in black tea*

	N %	P %	K %	Mg %	Ca %	Cu ppm	Mn ppm	Zn ppm	Fe ppm	Crude Protein (% N x 6.25)
BOPF										
PEKOE	4.39	0.34	1.93	0.182	0.423	31	142	38	248	27.4
BOP	3.90	0.303	2.10	0.186	0.362	22	148	25	218	24.4
FANNINGS	3.97	0.338	2.15	0.188	0.355	26	143	33	256	24.8
BM	4.10	0.317	2.05	0.191	0.350	28	148	37	249	25.6
DUST No. 1	3.34	0.273	1.95	0.193	0.510	18	148	41	128	20.9
DUST (Ordinary)	4.66	0.384	2.00	0.185	0.253	28	133	39	245	29.1
UNGRADED	3.86	0.308	1.90	0.187	0.256	28	148	46	279	24.1
REFUSE TEA	3.44	0.343	2.10	0.191	0.345	28	127	38	218	21.5
TEA FLUFF	2.49	0.21	2.00	0.168	0.35	22	146	34	188	15.6
	2.92	0.135	1.25	0.129	0.45	26	120	129	993	18.2

TABLE 2 – Hot water extractable nutrients in black tea

	N %	P %	K %	Mg %	Ca ppm	Cu ppm	Mn ppm	Zn ppm	Fe ppm	pH (tea brew)	C.P. %
BOPF	1.26	0.106	1.65	0.106	313	9.0	61	23.5	1.10	5.0	7.87
PEKOE	1.06	0.086	1.52	0.086	219	8.0	40	16.5	0.50	5.0	6.62
BOP	1.17	0.097	1.68	0.096	262	11.0	38	16.0	0.30	5.0	7.31
FANNINGS	1.27	0.102	1.73	0.101	250	11.5	51	16.5	0.70	5.0	7.75
BM	1.03	0.096	1.45	0.096	236	6.0	54	20.5	0.65	5.1	6.43
DUST No. 1	1.22	0.102	1.56	0.102	188	10.5	52	18.0	1.20	5.0	7.62
DUST (Ordinary)	1.20	0.104	1.90	0.104	250	13.5	54	25.0	0.80	5.0	7.50
UNGRADED	1.22	0.101	2.00	0.100	150	14.0	42	19.0	0.30	5.0	7.62
REFUSE TEA	0.99	0.091	1.90	0.090	250	10.5	45	15.0	1.20	5.0	6.18
TEA FLUFF	0.89	0.078	1.09	0.075	469	9.0	35	60.5	0.75	5.3	5.56

The pH of the tea brew was around 5 for all grades of tea showing that the hardness of water used did not affect the pH of the brew. The amount of cream (theaflavins, thearubigins and caffeine) increased with decrease in pH and reached a maximum at pH 4 (Sivapalan and Herath, 1986). Figures 1 and 2 show the amount of nitrogen, phosphorus, potassium and of magnesium, calcium and copper extracted in a cup brew (150 ml) with distilled water (DW) and tap water (TW) boiled in pyrex and aluminium kettle respectively.

The protein content of made tea ranges from 21 to 29 % (% N x 6.25). But hot water extracts only about 2 % of the protein. When milk is added to tea, it becomes an important source of protein. K content in distilled water (DW) and tap water (TW) brew did not vary much. But with time (10 min) in general more K was extracted in all the methods of brewing (Fig. 1). The amount of K in a cup of brew is about 300-450 ppm.

The amount of Ca getting into its tea liquor is small (1.5-3.0 ppm) when compared to the human need (requirement of an adult is 40-500 Mg per day). Calcium contribution by soft water is about 3.5 % of an adult intake and hard water by about 7 % (Wickremanayake, 1987).

The amount of Mg in tea liquor varies from 6-22 ppm (Fig. 2). Pekoe, consisting of mainly buds, brewed the lowest amount of Mg in all the methods of extraction. Slightly lower amount of Mg is extracted when water (distilled or tap water) was boiled in an Al kettle and the brewing time was 10 min. Magnesium is one of the major cation constituents of the human body and it plays an important part in the energy transfer system (Wickremanayake, 1987).

Although the amount of iron in made tea varied from 128-256 ppm, the amount of iron in tea brew is very low, whereas the Saudi Arabian Standard limit (SSA 275/1982) is 150 ppm (Fig. 3). It has been reported that most iron is present as non soluble organic complexes (Michie and Dixon, 1977).

It has been shown that manganese, copper and iron in tea are useful for the treatment of anaemia (Stagg and Millin, 1975). Copper in tea brew is far below the standard limit allowed by SSA which is 10 ppm. Further it was reported that copper is essential for the utilization of iron in haemoglobin synthesis (Wickremanayake, 1987).

Zn content in tea brew varied from 0.5 to 5 ppm (Fig. 3). When tap water was boiled in an Al kettle the amount of Zn extracted was slightly more. Further, when tap water was used for brewing, the Zn content was about 6 times more than the distilled water brew. This may be due to the fact that the pipe lines and storage tanks are made of galvanised material and contamination would have come from them. In all methods of brewing, the Zn in tea brew was below the SSA standard (50 ppm).

Manganese content in tea brew ranges from 1 to 4.2 ppm (Fig. 3). Tea provides about 150-600 mg Mn per cup. When water was boiled in an Al kettle and used for brewing, the Mn content was slightly higher in all grades of tea. As most food products are low in Mn, tea is valued as a source of Mn to human beings.

Lead was not detected in the infusion obtained by the various brewing methods. Michie and Dixon (1977) added 10 ppm lead and 10 ppm cadmium to black tea and brewed for 15 min and found that no lead or cadmium was recovered from the infusion.

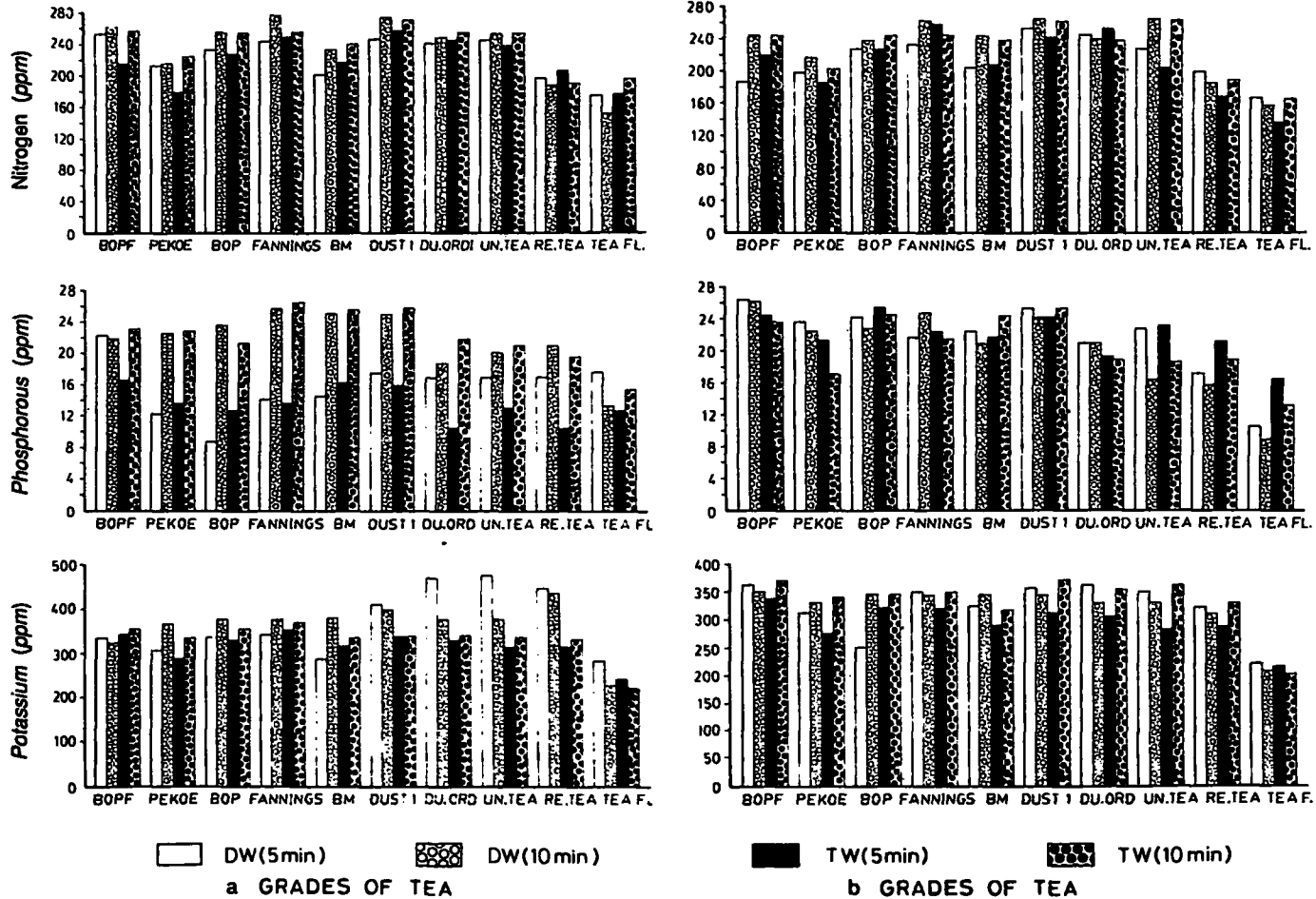


Fig. 1 – Amount of nitrogen, phosphorous and potassium extracted in a cup of brew prepared with distilled water (DW) and tap water (TW) boiled for 5 and 10 min in (a) pyrex vessel, (b) aluminium kettle, respectively

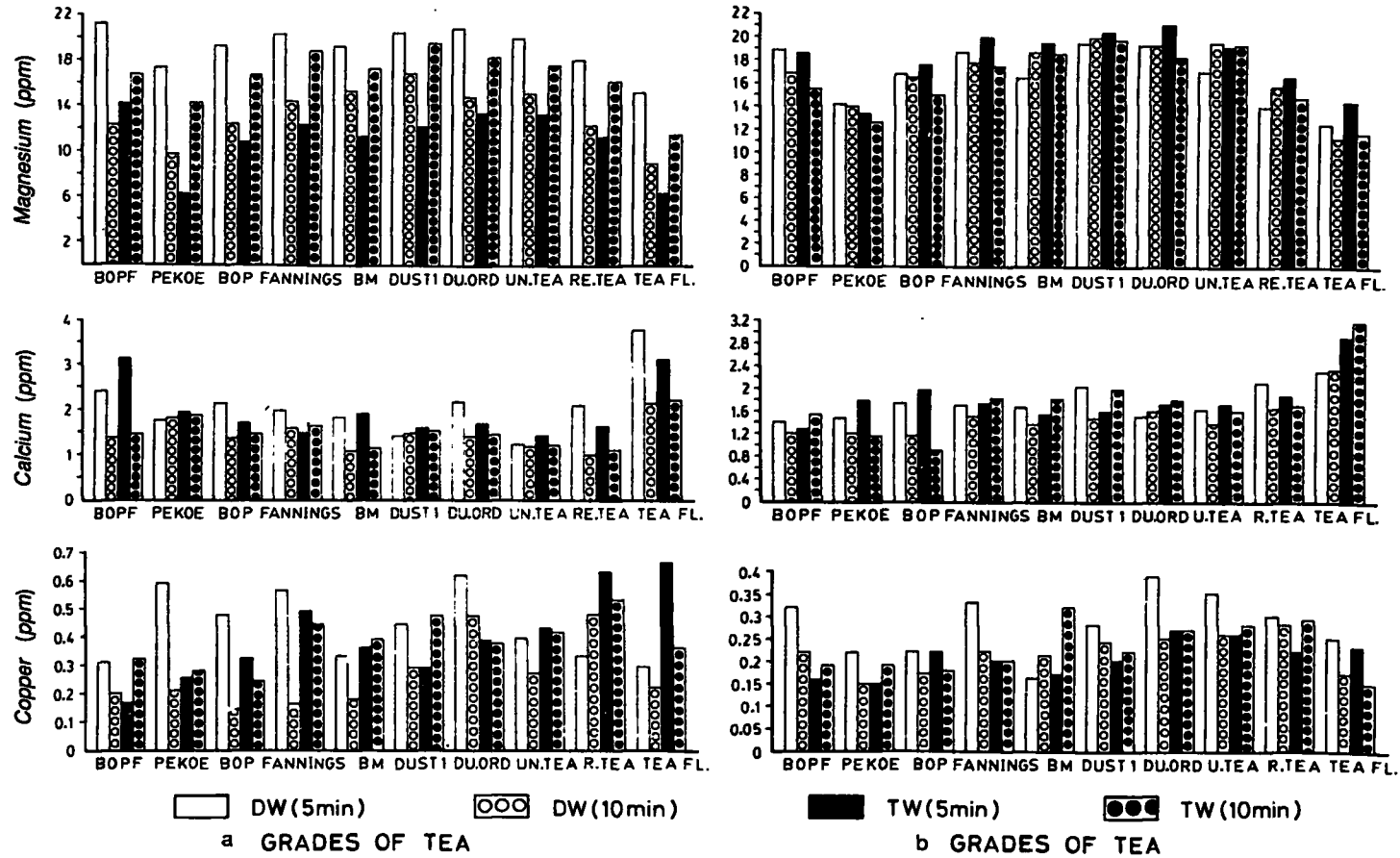


Fig. 2 – Amount of magnesium, calcium and copper extracted in a cup of brew prepared with distilled water (DW) and tap water (TW) boiled for 5 and 10 min in (a) pyrex vessel (b) aluminium kettle, respectively

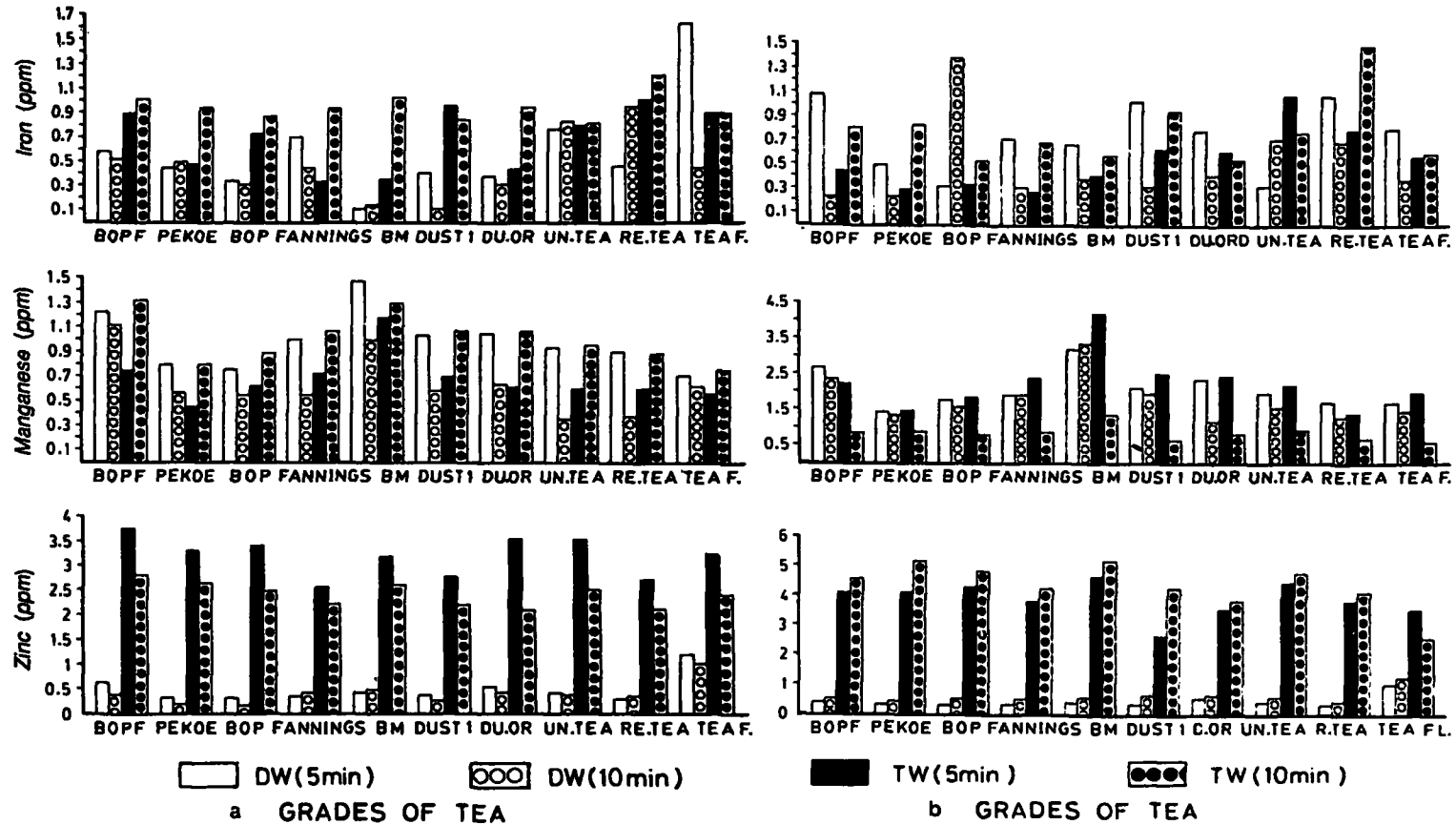


Fig. 3 – Amount of iron, manganese and zinc extracted in a cup of brew prepared with distilled water (DW) and tap water (TW) boiled for 5 and 10 min in (a) pyrex vessel, (b) aluminium kettle, respectively.

They concluded that soluble polyphenols (flavanol and catechin) in tea leaves have the ability to complex toxic metals like lead and cadmium making the brew non toxic. Further they reported that when black tea is separated from dust by sieving and lead determination was done on these two separately the lead content in dust was higher (2-3 ppm) than in black tea (0.5 ppm).

Although green tea is a good source of vitamin C, it almost disappears during fermentation. Tea is a source of vitamin B, E, K, and P (Gurser, 1987). Further, fluoride in black tea (100-200 ppm) is beneficial to dental caries. A person consuming 6 to 9 cups of tea will obtain sufficient quantity of fluoride necessary for the prevention of dental caries (Karunanayake *et al.*, 1972).

CONCLUSIONS

Although black tea is rich in many nutrients, the amount solubilised in the infusion is less compared to human needs. Tea brew is a valuable source of K, Mg, Mn and Cu for human consumption. No toxic metal such as lead passed into the infusion when tea brew was prepared. With tap water slightly more Zn was extracted into the brew but nevertheless it was well below the SAA 275/1982 limit. When the brewing time was increased from 5 to 10 min (unconventional) the extraction of all nutrients by all methods of extraction increased slightly. Different grades of tea contain different amounts of nutrients.

ACKNOWLEDGEMENTS

The authors thank Dr S. Sivasubramaniam for correcting the manuscript. We thank Messrs M. Sivendiran and N. Ekanayake for drawing the histograms, Mr D. L. Coonghe for photographing them and Mr P. W. Uduwawala for his neat typing of the manuscript.

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