

bile acids, plasma glucose, packed cell volume, systolic, and diastolic blood pressure obtained in the *Plasmodium*-infected patients before and after treatment with the extract [Table 1].

The results obtained showed a significantly higher mean value of plasma myoglobin, transferrin, SOD, and GPx in normal control subjects than the *Plasmodium*-infected patients before the treatment with $P < 0.05$ [Tables 2 and 3].

There was a significantly lower mean value of plasma transferrin, SOD, and GPx in *Plasmodium*-infected patients

before treatment than in *Plasmodium*-infected patients after treatment with $P < 0.05$. However, there was no significant difference in the value of myoglobin obtained in *Plasmodium*-infected patients before treatment and in the *Plasmodium*-infected patients after treatment with $P > 0.05$ [Tables 2 and 3].

The result obtained showed no significant difference in the mean value of plasma myoglobin, transferrin, SOD, and GPx in *Plasmodium*-infected male patients before treatment and *Plasmodium*-infected female patient before treatment ($P > 0.05$) as shown in Tables 2 and 3.

Table 1: Plasma TBA (µmol/L) plasma glucose (mg/dl) packed cell volume (%) systolic blood pressure (mmHg), and diastolic blood pressure (mmHg) in normal control subjects

Biochemical parameters	Normal control	Plasmodium infected patients before treatment	Plasmodium infected male patients before treatment	Plasmodium infected female patient before treatment	Plasmodium infected patients after treatment	Plasmodium infected male patients after treatment	Plasmodium infected female patients after treatment
<i>n</i>	50	48	24	24	48	24	24
TBA (µmol/L)	6.5±1.6	6.6±1.8	6.5±1.0	6.3±1.6	6.1±1.0	6.3±1.5	6.2±1.7
PCV (%)	40±6.1	39±5.1	42±2.1	37±3.0	40±4.1	41±3.1	38±2.5
Blood glucose (mg/dl)	90±15.0	88±14.0	89±15.1	91±14.0	86±13.0	88±14	89±14
Systolic blood pressure (mmHg)	110±10.0	117±2.1	110±9.0	118±2.0	115±5.0	117±2.0	117±3.0
Diastolic blood pressure (mmHg)	75±5.1	80±1.1	79±1.0	77±2.1	70±8.1	70±3.1	70±2.3

PCV: Packed cell volume, TBA: Total bile acids

Table 2: Results of plasma myoglobin, transferrin, SOD and GPx obtained in the control and *Plasmodium* infected subjects before and after treatment with the liquid extract of *Morinda lucida*

Biochemical parameters	Normal control	Plasmodium infected patients before treatment	Plasmodium infected male patients before treatment	Plasmodium infected female patient before treatment	Plasmodium infected patients after treatment	Plasmodium infected male patients after treatment	Plasmodium infected female patients after treatment
<i>n</i>	50	48	24	24	48	24	24
Myoglobin (ng/ml)	63±2.1	21±3.2	19±2.0	16±2.1	22±1.8	19.2±2.0	16.7±2.0
Transferrin (mg/dl)	300±1.1	279±2.0	281±3.0	280±4.0	390±2.5	383±6.0	392±2.0
SOD (U/ml)	3.01±0.2	1.8±0.3	1.7±0.1	1.8±0.2	2.8±0.1	2.4±0.1	2.9±0.3
GPx (U/L)	277±6.2	214±5.1	200±7.1	211±6.5	241±6.0	220±7.0	245±9.1

SOD: Superoxide dismutase, GPx: Glutathione peroxidase

Table 3: Comparative analysis of plasma myoglobin, transferrin, SOD and GPx obtained in the control and *Plasmodium*-infected subjects before and after treatment with the liquid extract of *Morinda lucida*

Biochemical parameters	Normal control and Plasmodium infected patients before treatment		Plasmodium infected patients before treatment and Plasmodium infected patients after treatment		Plasmodium infected male patients before treatment and Plasmodium infected female patient before treatment		Plasmodium infected male patients after treatment and Plasmodium infected female patient after treatment		Plasmodium infected male patients before and after treatment		Plasmodium infected female patients before and after treatment	
	<i>t</i>	<i>P</i>	<i>t</i>	<i>P</i>	<i>t</i>	<i>P</i>	<i>t</i>	<i>P</i>	<i>t</i>	<i>P</i>	<i>t</i>	<i>P</i>
Myoglobin (ng/ml)	15.0	0.02**	0.37	0.3*	0.2	0.4*	1.06	0.2*	0.2	0.4*	0.16	0.4*
Transferrin (mg/dl)	8.94	0.06**	3.59	0.03**	0.2	0.4*	1.42	0.14*	0.93	0.2*	2.67	0.05*
SOD (U/ml)	3.59	0.034**	3.5	0.03**	0.45	0.3*	2.04	0.08*	4.95	0.01**	3.05	0.04**
GPx (U/L)	8.06	0.07**	3.46	0.03**	1.20	0.1*	2.20	0.07*	2.02	0.09*	2.78	0.05*

*Not significant, **Significant. SOD: Superoxide dismutase, GPx: Glutathione peroxidase

The result obtained also showed no significant difference in the mean value of plasma myoglobin, transferrin, SOD, and GPx in *Plasmodium*-infected male patients after treatment and *Plasmodium*-infected female patient after treatment ($P > 0.05$) as shown in Tables 2 and 3.

The result obtained also showed no significant difference in the mean value of plasma myoglobin, transferrin, and GPx in *Plasmodium*-infected male patients before and after treatment with $P > 0.05$ [Tables 2 and 3].

There was a significantly lower mean value of plasma SOD in *Plasmodium*-infected male patients before than the result obtained after treatment with $P < 0.05$ [Tables 2 and 3].

The result obtained also showed no significant difference in the mean value of plasma myoglobin, transferrin, and GPx in *Plasmodium*-infected female patients before and after treatment with $P > 0.05$. However, there was a significantly lower mean value of plasma SOD in *Plasmodium*-infected female patients before than the result obtained after treatment with $P < 0.05$ [Tables 2 and 3].

DISCUSSION

There was no difference in the mean value of plasma total bile acids, plasma glucose, packed cell volume, systolic, and diastolic blood pressure obtained in the *Plasmodium*-infected patients before and after treatment with the extract. Plasma myoglobin, transferrin, SOD, and GPx were found to be significantly higher in normal control subjects than the *Plasmodium*-infected patients before the treatment. This is a result of *Plasmodium* infection, because malarial infection decreases the levels of antioxidant enzymes and other antioxidants such as catalase, GPx, SOD, albumin, GSH, ascorbate, and plasma tocopherol, which has also been demonstrated in mice to increase the activity of XOD and lipid peroxide content in liver, indicating development of hepatic oxidative stress in malaria.^[5-7]

There was a significantly lower mean value of plasma transferrin, SOD, and GPx in *Plasmodium*-infected patients before treatment than in *Plasmodium*-infected patients after treatment. Transferrin is an antioxidant and a negative acute-phase protein that decreases in inflammation by providing an innate immunity preventing tissue and cell damage.^[6] Oxidative damage is one of the most important pathological consequences of malarial infections. It affects vital organs of the body manifesting in changes such as splenomegaly, hepatomegaly, endothelial, and cognitive damages, therefore, low plasma transferrin, SOD, and GPx level is due to preventative (transferrin) and scavenging (SOD and GPx) effect of the these substances against the reactive oxygen

or the oxidative stress.^[17] The level of these antioxidants, therefore, increases after treatment affirming the liquid extract of *M. lucida* as an antiparasitological agent.^[18] Furthermore, phytochemicals found in *M. lucida* leaf such as alkaloids, saponins, flavonoids, and have antioxidant activities.^[8-14]

There was a significantly lower mean value of plasma SOD in *Plasmodium*-infected male patients before than the result obtained after treatment. This was also found in female patients. The above explanation also holds for this finding.

CONCLUSION

Oxidative stress in *Plasmodium* infection is prevalent due to a significant decrease in the plasma myoglobin, transferrin, SOD, and GPx. The preventative and scavenging antioxidative properties of the liquid extract of *M. lucida* leaf was evident due to alterations in the plasma level of transferrin, SOD, and GSH peroxidase in *Plasmodium*-infected patients.

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Conflicts of interest

There are no conflicts of interest.

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