

SUMMARY OF PRODUCT CHARACTERISTICS

1. NAME OF THE MEDICINAL PRODUCT

Dihydroartemisinin /piperaquine phosphate 40 mg / 320 mg Tablets (D-ARTEPP®).
Dihydroartemisinin /Piperaquine phosphate 60 mg /480 mg Tablets (D-ARTEPP®).
Dihydroartemisinin /piperaquine phosphate 80 mg / 640 mg Tablets (D-ARTEPP®).

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each tablet contains Dihydroartemisinin 40 mg and piperaquine phosphate 320 mg.
Each tablet contains Dihydroartemisinin 60 mg and piperaquine phosphate 480 mg.
Each tablet contains Dihydroartemisinin 80 mg and piperaquine phosphate 640 mg.
For a full list of excipients, see section 6.1

3. PHARMACEUTICAL FORM

D-ARTEPP® 40 mg / 320 mg tablets are blue round, film-coated tablet debossed with a score line on one side.

D-ARTEPP® 60 mg / 480 mg tablets are blue capsule-shaped, film-coated tablet with a score line on one side.

D-ARTEPP® 80 mg / 640 mg tablets are blue capsule-shaped, biconvex film-coated tablet debossed with a score line on one side.

The score line is intended for subdivision of tablets when half a tablet dose is to be administered as supported by divisibility studies.

4. CLINICAL PARTICULARS

4.1 Therapeutic indications

D-ARTEPP® is indicated for the treatment of uncomplicated malaria in adults, children and infants. It is active against all *Plasmodium* parasites that cause malaria in humans.

Consideration should be given to official guidance on the appropriate use of antimalarial medicinal products.

4.2 Posology and method of administration Posology

D-ARTEPP® should be administered over three consecutive days for a total of three doses taken at the same time each day.

Dosing should be based on body weight as shown in the following table:

Body weight	Daily Dose(mg)
17 kg to less than 25 kg	One and half 40 mg / 320 mg tablets per day for 3 days or One 60 mg / 480 mg tablet per day for 3 days
25 kg to less than 36 kg	Two 40 mg / 320 mg tablets per day for 3 days or One 80 mg / 640 mg tablet per day for 3 days
36 kg to less than 60 kg	Three 40 mg / 320 mg tablets per day for 3 days or Two 60 mg / 480 mg tablets per day for 3 days or One and half 80 mg / 640 mg tablets per day for 3 days
60 kg to less than 80 kg	Four 40 mg / 320 mg tablets per day for 3 days or Two 80 mg / 640 mg tablets per day for 3 days
80 kg or more	Five 40 mg / 320 mg tablets per day for 3 days or Two and half 80 mg / 640 mg tablets per day for 3 days

If a patient vomits within 30 minutes of taking D-ARTEPP® Tablets, the whole dose should be re-administered; if a patient vomits within 30-60 minutes, half the dose should be re-administered. Re-dosing with D-ARTEPP® Tablets should not be attempted more than once. If the second dose is vomited, alternative antimalarial therapy should be started.

If a dose is missed, it should be taken as soon as realized and then the recommended regimen continued until the full course of treatment has been completed.

There are no data on a second course of treatment.

No more than two courses of this product may be given within a 12-month period (see sections 4.4 and 5.3).

A second course of D-ARTEPP® Tablets should not be given within 2 months after the first course due to the long elimination half-life of piperazine (see sections 4.4 and 5.2).

Special populations

Elderly

Clinical studies of D-ARTEPP® Tablets did not include patients aged 65 years and over, therefore no dosing recommendation can be made. Considering the possibility of age-associated decrease in hepatic and renal function, as well as a potential for heart disorders (see sections 4.3 and 4.4), caution should be exercised when administering the product to the elderly.

Hepatic and renal impairment

D-ARTEPP® Tablets has not been evaluated in subjects with moderate or severe renal or hepatic insufficiency. Therefore, caution is advised when administering D-ARTEPP® Tablets to these patients (see section 4.4).

Method of administration

D-ARTEPP® Tablets should be taken orally with water and without food:

- Each dose should be taken no less than three hours after the last food intake.
- No food should be taken within 3 hours after each dose.

For patients unable to swallow the tablets, D-ARTEPP® Tablets may be crushed and mixed with water. The mixture should be swallowed immediately after preparation.

4.3 Contraindications

- Hypersensitivity to the active substances or to any of the excipients listed in section 6.1.
- Severe malaria according to WHO definition.
- Family history of sudden death or of congenital prolongation of the QTc interval.
- Known congenital prolongation of the QTc interval or any clinical condition known to prolong the QTc interval.
- History of symptomatic cardiac arrhythmias or with clinically relevant bradycardia.
- Any predisposing cardiac conditions for arrhythmia such as severe hypertension, left ventricular hypertrophy (including hypertrophic cardiomyopathy) or congestive cardiac failure accompanied by reduced left ventricle ejection fraction.
- Electrolyte disturbances, particularly hypokalaemia, hypocalcaemia or hypomagnesaemia.
- Taking medicinal products that are known to prolong the QTc interval. These include (but are not limited to):
 - Antiarrhythmics (e.g. amiodarone, disopyramide, dofetilide, ibutilide, procainamide, quinidine, hydroquinidine, sotalol).
 - Neuroleptics (e.g. phenothiazines, sertindole, sultopride, chlorpromazine, haloperidol, mesoridazine, pimozide, or thioridazine), antidepressive medicinal products.
 - Certain antimicrobial medicinal products, including medicinal products of the following classes:
 - macrolides (e.g. erythromycin, clarithromycin),
 - fluoroquinolones (e.g. moxifloxacin, sparfloxacin),
 - imidazole and triazole antifungal medicinal products,
 - pentamidine and saquinavir.
 - Certain non-sedating antihistamines (e.g. terfenadine, astemizole, mizolastine).
 - Cisapride, droperidol, domperidone, bepridil, diphemanil, probucol,

levomethadyl, methadone, vinca alkaloids, arsenic trioxide.

- Recent treatment with medicinal products known to prolong the QTc interval that may still be circulating at the time that Eurartesim is started (e.g. mefloquine, halofantrine, lumefantrine, chloroquine, quinine and other antimalarial medicinal products) taking into account their elimination half-life.

4.4 Special warnings and precautions for use

D-ARTEPP® Tablets should not be used to treat complicated malaria.

The long half-life of piperazine (about 22 days) should be kept in mind in the event that another antimalarial agent is started due to treatment failure or a new malaria infection (see below and sections 4.3 and 4.5).

Piperazine is a mild inhibitor of CYP3A4. Caution is recommended when co-administering D-ARTEPP® Tablets with medicinal products exhibiting variable patterns of inhibition, induction or competition for CYP3A4 as the therapeutic and/or toxic effects of some co-administered medicinal products could be altered.

Piperazine is also a substrate of CYP3A4. A moderate increase of piperazine plasma concentrations (<2- fold) was observed when co-administered with strong CYP3A4 inhibitors, resulting in a potential exacerbation of the effect on QTc prolongation (see section 4.5).

Exposure to piperazine may also be increased when co-administered with mild or moderate CYP3A4- inhibitors (e.g. oral contraceptives). Therefore, caution should be applied when co-administering D-ARTEPP® Tablets with any CYP3A4-inhibitor and ECG monitoring should be considered.

Due to the lack of multiple dose PK data for piperazine, administration of any strong CYP3A4-inhibitors should be discouraged after initiation (i.e. the first dose) of D-ARTEPP® Tablets (see sections 4.5 and 5.2).

D-ARTEPP® Tablets should not be used during pregnancy in situations where other suitable and effective antimalarials are available (see section 4.6).

In the absence of carcinogenicity study data, and due to lack of clinical experience with repeated courses of treatment in humans, no more than two courses of D-ARTEPP® Tablets should be given in a 12-month period (see sections 4.2 and 5.3).

Effects on cardiac repolarization

In clinical trials with piperazine/dihydroartemisinin limited ECGs were obtained during treatment. These showed that QTc prolongation occurred more frequently and to a larger extent in association with piperazine/dihydroartemisinin therapy than with the comparators (see section 5.1 for details of the comparators). Analysis of cardiac adverse events in clinical trials showed that these were reported more frequently in piperazine/dihydroartemisinin-treated patients than in those treated with comparator antimalarial (see section 4.8). Before the third dose of piperazine/dihydroartemisinin, in one of the two Phase III studies 3/767 patients (0.4%) were reported to have a QTcF value of >500 milliseconds (ms) versus none in the comparator group.

The WHO guidelines no longer recommend performing an ECG before prescribing piperazine/dihydroartemisinin. However, piperazine/dihydroartemisinin should not be used in patients with known congenital long QT interval syndromes or those who have a clinical condition or are taking medication that prolongs the QT interval.

There has been no evidence of piperazine-related cardiotoxicity in large randomized trials or in extensive deployment in the field.

Delayed Haemolytic Anaemia

Delayed haemolytic anaemia has been observed up to one month following use of IV artesunate and oral artemisinin-based combination treatment (ACT) including reports involving piperazine/dihydroartemisinin. Risk factors may include young age (children under 5 years old) and previous treatment with IV artesunate.

Patients and caregivers should be advised to be vigilant for signs and symptoms of post-treatment haemolysis such as pallor, jaundice, dark-coloured urine, fever, fatigue, shortness of

breath, dizziness and confusion.

Paediatric population

Special precaution is advised in young children when vomiting, as they are likely to develop electrolyte disturbances. These may increase the QTc-prolonging effect of D-ARTEPP® Tablets.

Hepatic and renal impairment

Piperaquine/dihydroartemisinin has not been evaluated in patients with moderate or severe renal or hepatic insufficiency (see section 4.2). Due to the potential for higher plasma concentrations of piperaquine to occur, caution is advised if D-ARTEPP® Tablets is administered to patients with jaundice and/or with moderate or severe renal or hepatic insufficiency, and ECG and blood potassium monitoring are advised.

4.5 Interaction with other medicinal products and other forms of interaction

D-ARTEPP® Tablets is contraindicated in patients already taking other medicinal products that are known to prolong the QTc interval due to the risk of a pharmacodynamic interaction leading to an additive effect on the QTc interval (see sections 4.3 and 4.4).

A limited number of drug-drug pharmacokinetic interaction studies with D-ARTEPP® Tablets have been performed in healthy adult subjects. The assessment of the potential for drug-drug interactions to occur is therefore based on either *in vivo* or *in vitro* studies.

Effect of D-ARTEPP® Tablets on co-administered medicinal products

Piperaquine is metabolised by, and is an inhibitor of, CYP3A4. The concurrent administration of oral D-ARTEPP® Tablets with 7.5 mg oral midazolam, a CYP3A4 probe substrate, led to a modest increase (≤ 2 - fold) in midazolam and its metabolites exposure in healthy adult subjects. This inhibitory effect was no longer evident one week after last administration of D-ARTEPP® Tablets. Therefore, particular attention should be paid when medicinal products that have a narrow therapeutic index (e.g. antiretroviral medicinal products and cyclosporine) are co-administered with D-ARTEPP® Tablets.

From *in vitro* data, piperaquine undergoes a low level of metabolism by CYP2C19, and is also an inhibitor of this enzyme. There is the potential for reducing the rate of metabolism of other substrates of this enzyme, such as omeprazole, with consequent increase of their plasma concentration, and therefore, of their toxicity.

Piperaquine has the potential to increase the rate of metabolism for CYP2E1 substrates resulting in a decrease in the plasma concentrations of substrates such as paracetamol or theophylline, and the anaesthetic gases enflurane, halothane and isoflurane. The main consequence of this interaction could be a reduction of efficacy of the co-administered medicinal products.

Dihydroartemisinin administration may result in a slight decrease in CYP1A2 activity. Caution is therefore, advised when D-ARTEPP® Tablets is administered concomitantly with medicinal products metabolised by this enzyme that have a narrow therapeutic index, such as theophylline. Any effects are unlikely to persist beyond 24 hours after the last intake of dihydroartemisinin.

Effect of co-administered medicinal products on D-ARTEPP® Tablets

Piperaquine is metabolized by CYP3A4 *in vitro*. The concurrent administration of a single dose of oral clarithromycin, (a strong CYP3A4 inhibitor probe) with a single dose of oral D-ARTEPP® Tablets led to a modest increase (≤ 2 -fold) in piperaquine exposure in healthy adult subjects. This increase in exposure to the antimalarial combination may result in an exacerbation of the effect on QTc (see section 4.4). Therefore, particular caution is required if D-ARTEPP® Tablets is administered to patients taking potent CYP3A4 inhibitors (e.g. some protease inhibitors [amprenavir, atazanavir, indinavir, nelfinavir, ritonavir], nefazodone or verapamil), and ECG monitoring should be considered due to the risk of higher plasma concentrations of piperaquine (see section 4.4).

Enzyme-inducing medicinal products such as rifampicin, carbamazepine, phenytoin, phenobarbital, St. John's wort (*Hypericum perforatum*) are likely to lead to reduced piperaquine plasma concentrations. The concentration of dihydroartemisinin may also be reduced. Concomitant treatment with such medicinal products is not recommended.

Paediatric population

Drug-drug interaction studies have only been performed in adults. The extent of interactions in the paediatric population is not known. The interactions documented above for adults and the warnings in section 4.4 should be considered for the paediatric population.

Oral contraceptives

When co-administered to healthy women, D-ARTEPP® Tablets exerted only a minimum effect on an estrogen/progestinic combination oral contraceptive treatment, increasing the ethynilestradiol rate of absorption (expressed by geometric mean C_{max}) by about 28% but not significantly changing the exposure to ethynilestradiol and levonorgestrel and not influencing contraception activity as demonstrated by the similar plasma concentrations of follicle stimulating hormone (FSH), luteinizing hormone (LH) and progesterone observed after oral contraceptive treatment with or without concomitant D-ARTEPP® Tablets administration.

Food interaction

Absorption of piperazine is increased in the presence of fatty food (see sections 4.4 and 5.2) which may increase its effect on QTc interval. Therefore, D-ARTEPP® Tablets should be taken with water only, as described in section 4.2. D-ARTEPP® Tablets should not be taken with grapefruit juice as it is likely to lead to increased piperazine plasma concentrations.

4.6 Fertility, pregnancy and breastfeeding

Pregnancy

There are insufficient data on the use of dihydroartemisinin and piperazine in pregnant women. Based on animal data, piperazine/dihydroartemisinin is suspected to cause serious birth defects when administered during the first trimester of pregnancy (see sections 4.4 and 5.3). Reproductive studies with artemisinin derivatives have demonstrated teratogenic potential with an increased risk during early gestation (see section 5.3). Piperazine was not teratogenic in the rat or rabbit. In perinatal and postnatal studies in rats, piperazine was associated with delivery complications. However, there was no delay in neonatal development following exposure *in utero* or via milk.

D-ARTEPP® Tablets should not be used during pregnancy in situations where other suitable and effective antimalarials are available (see section 4.4).

Breast-feeding

Animal data suggest excretion of piperazine into breast milk, but no data are available in humans. Women taking D-ARTEPP® Tablets should not breast-feed during their treatment.

Fertility

There are no specific data relating to the effects of piperazine on fertility, however, to date no adverse events have been reported during clinical use. Moreover, data obtained in animal studies show that fertility is unaffected by dihydroartemisinin in both females and males.

4.7 Effects on ability to drive and use machines

Adverse event data collected in clinical trials suggest that D-ARTEPP® Tablets have no influence on the ability to drive and operate machines once the patient has recovered from the acute infection.

4.8 Undesirable effects

Summary of the safety profile

The safety of piperazine/dihydroartemisinin has been evaluated in two phase III open-label studies involving 1,239 paediatric patients up to 18 years and 566 adult patients >18 years treated with piperazine/dihydroartemisinin.

In a randomized trial in which 767 adults and children with uncomplicated *P. falciparum* malaria were exposed to piperazine/dihydroartemisinin, 25% of subjects were judged to have experienced an adverse drug reaction (ADR). No single type of ADR occurred at an incidence of $\geq 5\%$. The most frequent ADRs observed at an incidence $\geq 1.0\%$ were: headache (3.9%), electrocardiogram QTc prolonged (3.4%), *P. falciparum* infection (3.0%), anaemia (2.8%), eosinophilia (1.7%), haemoglobin decreased (1.7%), sinus tachycardia (1.7%), asthenia (1.6%),

haematocrit [decreased] (1.6%), pyrexia (1.5%), red blood cell count decreased (1.4%). A total of 6 (0.8%) subjects had serious ADRs in the study.

In a second randomized trial, 1,038 children, aged between 6 months and 5 years, were exposed to piperazine/dihydroartemisinin and 71% were judged to have experienced an ADR. The following ADRs were observed at an incidence of $\geq 5.0\%$: cough (32%), pyrexia (22.4%), influenza (16.0%), *P. falciparum* infection (14.1%), diarrhoea (9.4%), vomiting (5.5%) and anorexia (5.2%). A total of 15 (1.5%) subjects had serious ADRs in the study.

Tabulated list of adverse reactions

In the tables below, ADRs are listed under system organ class (SOC) and ranked by headings of frequency. Within each frequency grouping, adverse reactions are presented in the order of decreasing seriousness, using the following convention: very common ($\geq 1/10$), common ($\geq 1/100$ to $< 1/10$), uncommon ($\geq 1/1,000$ to $< 1/100$), rare ($\geq 1/10,000$ to $< 1/1,000$), very rare ($< 1/10,000$), not known (cannot be estimated from the available data). The table in this section is for adult patients only. A corresponding table for paediatric patients is presented in the specific section below.

Frequency of ADRs in adult patients participating in clinical studies with D-ARTEPP® Tablets:

SOC	Very common	Common	Uncommon
Infections and infestations		<i>P. falciparum</i> infection	Respiratory tract infection; influenza
Blood and lymphatic system disorders		Anaemia	
Metabolism and nutrition disorders			Anorexia
Nervous system disorders		Headache	Convulsion; dizziness
Cardiac disorders		QTc interval prolongation; tachycardia	Cardiac conduction disorders; sinus arrhythmia; bradycardia
Respiratory, thoracic and mediastinal disorders			Cough
Gastrointestinal disorders			Vomiting; diarrhoea; nausea; abdominal pain
Hepatobiliary disorders			Hepatitis; hepatomegaly; abnormal liver function tests
Skin and subcutaneous tissue disorders			Pruritis
Musculoskeletal and connective tissue disorders			Arthralgia; myalgia
General disorders and administration site conditions		Asthenia; pyrexia	

Description of selected adverse reactions

The ADRs noted for piperazine/dihydroartemisinin were generally mild in severity, and the majority were non-serious. Reactions such as cough, pyrexia, headache, *P. falciparum* infection, anaemia, asthenia, anorexia and the observed changes in blood cell parameters are consistent

with those expected in patients with acute malaria. The effect on prolongation of the QTc interval was observed on Day 2 and had resolved by Day 7 (the next time point at which ECGs were performed).

Paediatric population

A tabular overview of the frequency of the ADRs in paediatric patients is given below. The majority of paediatric experience is derived from African children aged 6 months to 5 years.

Frequency of ADRs in paediatric patients participating in clinical studies with D-ARTEPP® Tablets:

SOC	Very common	Common	Uncommon
Infections and infestations	Influenza; <i>P. falciparum</i> infection	Respiratory tract infection; ear infection	
Blood and lymphatic system disorders		Thrombocytopenia; leukopenia/neutropenia; leukocytosis; anaemia	Thrombocytosis; splenomegaly; lymphadenopathy; hypochromasia
Metabolism and nutrition disorders		Anorexia	
Nervous system disorders			Convulsion; headache
Eye disorders		Conjunctivitis	
Cardiac disorders		QTc interval prolongation; heart rate irregular	Cardiac conduction disorders; cardiac murmur
Respiratory, thoracic and mediastinal disorders	Cough		Rhinorrhoea; epistaxis
Gastrointestinal disorders		Vomiting; diarrhoea; abdominal pain	Stomatitis; nausea
Hepatobiliary disorders			Hepatitis; hepatomegaly; abnormal liver function tests; jaundice
Skin and subcutaneous tissue disorders		Dermatitis; rash	Acanthosis; pruritis
Musculoskeletal and connective tissue disorders			Arthralgia
General disorders and administration site conditions	Pyrexia	Asthenia	

Reporting of suspected adverse reactions

Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions via the national reporting system listed in Appendix V.

Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Health care

professionals are asked to report any suspected adverse reactions to the marketing authorisation holder, or, if available, via the national reporting system.

4.9 Overdose

In clinical trials, nine patients received double the cumulative intended dose piperazine/dihydroartemisinin. The safety profile of these patients did not differ from that of patients receiving the recommended dose, with no patient reporting SAEs.

In cases of suspected overdose, symptomatic and supportive therapy should be given as appropriate, including ECG monitoring because of the possibility of QTc interval prolongation (see section 4.4).

5. PHARMACOLOGICAL PROPERTIES

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Antiprotozoals, antimalarials, artemisinin and derivatives, combinations, ATC code: P01BF05

Pharmacodynamic effects

Dihydroartemisinin is able to reach high concentrations within the parasitized erythrocytes. Its endoperoxide bridge is thought to be essential for its antimalarial activity, causing free-radical damage to parasite membrane systems including:

- Inhibition of *falciparum* sarcoplasmic-endoplasmic reticulum calcium ATPase
- Interference with mitochondrial electron transport
- Interference with parasite transport proteins
- Disruption of parasite mitochondrial function

The exact mechanism of action of piperazine is unknown, but it likely mirrors that of chloroquine, a close structural analogue. Chloroquine binds to toxic haem (derived from the patient's haemoglobin) within the malaria parasite, preventing its detoxification via a polymerisation step.

Piperazine is a bisquinolone, and this class has shown good antimalarial activity against chloroquine-resistant *Plasmodium* strains *in vitro*. The bulky bisquinolone structure may be important for activity against chloroquine-resistant strains, and may act through the following mechanisms:

- Inhibition of the transporters that efflux chloroquine from the parasite food vacuole
- Inhibition of haem-digestion pathway in the parasite food vacuole.

Resistance to piperazine (when used as monotherapy) has been reported.

The efficacy and safety of piperazine/dihydroartemisinin have been assessed in two large randomized, open-label clinical trials:

Study DM040010 was conducted in Asian adult and paediatric patients with uncomplicated *P. falciparum* malaria. Piperazine/dihydroartemisinin (PPQ/DHA) treatment was compared with Artesunate + Mefloquine (AS + MQ). The primary endpoint was the PCR-corrected cure rate at Day 63.

Study DM040011 was conducted in African paediatric patients with uncomplicated *P. falciparum* malaria. Piperazine/dihydroartemisinin (PPQ/DHA) treatment was compared with Artemether + Lumefantrine (A + L). The primary endpoint was PCR-corrected cure rate at Day 28.

The results for the primary endpoint in the modified intent to treat (m-ITT) populations (defined as all randomised patients who received at least one dose of the study treatment, with the exclusion of those patients lost to follow up for unknown reasons) were as follows:

Study	PCR-corrected cure rate (m-ITT)			
	PPQ/DHA	AS+MQ	A+L	95 % two-sided CI on the treatment difference (PPQ/DHA - Comparator)
DM040010 (n=1087)	97.0%	95.3%	-	(-0.84, 4.19) %; p=0.161
DM040011 (n=1524)	92.7%	-	94.8%	(-4.59, 0.45) %; p=0.128

In each case the results confirmed that PPQ/DHA was not inferior to the comparator medicinal product. In both studies, the true treatment failure rate was below the 5% efficacy threshold set by WHO.

The age-specific PCR-corrected cure rates in the m-ITT populations are tabulated below for the Asian and African studies, respectively:

Study	PCR-corrected cure rate (m-ITT)			
	PPQ/DHA	AS+MQ	A+L	95 % two-sided CI on the treatment difference (PPQ/DHA - Comparator)
DM04010 (n=1087)				
≤5 years	100.0%	100.0%	-	-
>5 to ≤12 years	98.2%	96.5%	-	(-3.67, 7.09) %; p=0.605
>12 to ≤18 years	97.3%	100.0%	-	(-6.40, 0.99) %; p=1.000
>18 to ≤64 years	96.6%	94.4%	-	(-0.98, 5.30) %; p=0.146
DM04011 (n=1524)				
≤1 year	91.5%	-	98.5%	(-12.66, -1.32) % ⁽¹⁾ ; p=0.064
>1 to ≤2 years	92.6%	-	94.6%	(-6.76, 2.63) %; p=0.413
>2 to ≤5 years	93.0%	-	94.0%	(-4.41, 2.47) %; p=0.590

⁽¹⁾ This CI is asymptotic because the exact CI could not be computed.

5.2 Pharmacokinetic properties

No pharmacokinetic data are available for D-ARTEPP® 60 mg / 480 mg Tablets. A bioequivalence study was conducted with D-ARTEPP® 80 mg / 640 mg Tablets and D-ARTEPP® 40 mg / 320 mg Tablets, which are qualitatively similar and with respect to the ratio of active and other ingredients essentially the same as D-ARTEPP® 60 mg / 480 mg Tablets.

The absorption characteristics of D-ARTEPP® 80 mg / 640 mg Tablets have been determined after administration of an FDC of Dihydroartemisinin/ Piperazine Tetraphosphate 80 mg / 640 mg film-coated tablets in healthy volunteers in the fasting state as follows:

Pharmacokinetic variable*	Mean value ± standard deviation(*)	
	Dihydroartemisinin	Piperaquine
Maximum concentration (C _{max})	150 ± 78 (135)	94 ± 58 (77)
Area under the curve (AUC _{0-∞}), a measure of the extent of absorption ng.hour/ml	287 ± 121 --	3226 ± 1903 --
Time to attain maximum concentration (t _{max}) hour	1.36 ± 0.65	4.26 ± 1.81

*geometric mean

The absorption characteristics of D-ARTEPP® Tablets have been determined after administration of D-ARTEPP® 40 mg / 320 mg FDC tablets in healthy volunteers in the fasting state as follows:

Pharmacokinetic variable [*]	Mean value $\pm$ standard deviation(*)	
	Dihydroartemisinin	Piperaquine
Maximum concentration (C_{max})	287 $\pm$ 154 (259)	91 $\pm$ 55 (77)
Area under the curve ($AUC_{0-\infty}$), a measure of the extent of absorption ng. hour/ml	674 $\pm$ 389 --	3226 $\pm$ 1903 --
Time to attain maximum concentration (t_{max}) hour	1.55 $\pm$ 0.73	4.26 $\pm$ 1.81

*geometric mean

A biowaiver was granted for D-ARTEPP® 60 mg / 480 mg Tablets (Guilin Pharmaceuticals Ltd, India) in accordance to the WHO guideline. In comparison with the strength of the test product used in the bioequivalence studies, D-ARTEPP® 60 mg / 480 mg Tablets was determined to be qualitatively essentially the same, the ratio of active ingredient and excipients between the strengths was considered essentially the same and the dissolution profiles between the two formulations were determined to be the same.

	Dihydroartemisinin	Piperaquine
General		
	Bioavailability is higher in patients with malaria compared to healthy volunteers.	
Absorption		
Absolute bioavailability	NA	NA
Oral Bioavailability	NA	NA
Food effect	Exposure increased by 43% with a high fat/high calorie meal	Exposure increased approximately 3-fold with a high fat/high calorie meal
Distribution		
Volume of distribution (mean)	0.8 L/kg	730 L/kg
Plasma protein binding <i>in vitro</i>	44–93%	> 99%
Tissue distribution	Accumulates in red blood cells	Accumulates in red blood cells
Metabolism		
	Hepatic glucuronidation to α -artenimol- β -glucuronide	Hepatic: major metabolites are a carboxyl acid cleavage product and a mono-N-oxidated product
Elimination		
Mean elimination half-life	1 hour	22 days
Mean oral clearance	1.34 L/h/kg	2.1 L/h/kg
% of dose excreted in urine	Negligible as intact drug	NA
% of dose excreted in faeces	Negligible as intact drug	NA
Pharmacokinetic linearity	NA	NA
Drug interactions (<i>in vitro</i>)		
Transporters	NA	NA
Metabolizing enzymes	UGT1A9 and UGT2B7	CYP3A4 (mainly), CYP2C9 and CYP2C19

	Inhibitor of CYP1A2	Mild inhibitor of CYP3A4 and CYP2C19 Inducer of CYP2E1
Special populations		
Renal impairment	NA	NA
Hepatic impairment	NA	NA
Elderly patients	NA	NA

NA: Not available

Patients with hepatic or renal insufficiency

No specific pharmacokinetic studies have been performed in patients with hepatic or renal insufficiency, or in elderly people.

Paediatrics

In a paediatric pharmacokinetic study, and based on very limited sampling, minor differences were observed for dihydroartemisinin pharmacokinetics between the paediatric and adult populations. The mean clearance (1.45 L/h/kg) was slightly faster in the paediatric patients than in the adult patients (1.34 L/h/kg), while the mean volume of distribution in the paediatric patients (0.705 L/kg) was lower than in the adults (0.801L/kg).

The same comparison showed that piperazine absorption rate constant and terminal half-life in children were predominantly similar to those seen in adults. However, the apparent clearance was faster (1.30 versus 1.14 L/h/kg) and the apparent total volume of distribution was lower in the paediatric population (623 versus 730 L/kg).

5.3 Preclinical safety data

General toxicity

Literature data concerning chronic toxicity of piperazine in dogs and monkeys indicate some hepatotoxicity and mild reversible depression of total white cell and neutrophil counts.

The most important nonclinical safety findings after repeated dosing were the infiltration of macrophages with intracytoplasmic basophilic granular material consistent with phospholipidosis and degenerative lesions in numerous organs and tissues. These adverse reactions were seen in animals at exposure levels similar to clinical exposure levels, and with possible relevance to clinical use. It is not known whether these toxic effects are reversible.

Dihydroartemisinin and piperazine were not genotoxic/clastogenic based on *in vitro* and *in vivo* testing.

No carcinogenicity studies have been performed.

Dihydroartemisinin causes embryoletality and teratogenicity in rats and rabbits.

Piperazine did not induce malformation in rats and rabbits. In a perinatal and postnatal development study (segment III) in female rats treated with 80 mg/kg, some animals had a delay of delivery inducing mortality of the neonates. In females delivering normally, the development, behaviour and growth of the surviving progeny was normal following exposure *in utero* or via milk.

No reproduction toxicity studies have been performed with the combination of dihydroartemisinin and piperazine.

Central nervous system (CNS) toxicity

There is potential for neurotoxicity of artemisinin derivatives in man and animals, which is strongly related to the dose, route and formulations of the different dihydroartemisinin pro-drugs. In humans, the potential neurotoxicity of orally administered dihydroartemisinin can be considered highly unlikely, given the rapid clearance of dihydroartemisinin, and its short exposure (3 days of treatment for malaria patients). There was no evidence of dihydroartemisinin-induced lesions in the specific nuclei in rats or dogs, even at lethal dose.

Cardiovascular toxicity

Effects on blood pressure and on PR and QRS duration were observed at high piperazine doses. The most important potential cardiac effect was related to cardiac conduction.

In the hERG test, the IC₅₀ was 0.15 µmol for piperazine and 7.7 µmol for dihydroartemisinin. The association of dihydroartemisinin and piperazine does not produce hERG inhibition greater than that of the single compounds.

Phototoxicity

There are no phototoxicity concerns with dihydroartemisinin, as it does not absorb in the range of 290–700 nm. Piperazine has an absorption maximum at 352 nm. Since piperazine is present in the skin (about 9% in the non-pigmented rat and only 3% in the pigmented rat), slight phototoxic reactions (swelling and erythema) were observed 24 hours after oral treatment in mice exposed to UV radiation.

6. PHARMACEUTICAL PARTICULARS

6.1 List of excipients

Core tablet: Pregelatinized starch, Hypromellose, Dextrin, Croscarmellose sodium, Magnesium stearate

Film coat: Polyvinyl alcohol, Titanium dioxide, Macrogol/ Polyethylene glycol, Talc, FD&C Blue#2/Indigo carmine aluminium lake

6.2 Incompatibilities

Not applicable.

6.3 Shelf life

24 months

6.4 Special precautions for storage

Store in tightly closed containers, protected from light and moisture, not above 25°C.

6.5 Nature and contents of container

D-ARTEPP® 40 mg / 320 mg:

PA/Alu/PVC-Alu blister. Each blister contains 6 or 9 tablets. 1 or 25 such blisters are packed in a box. Pack sizes: 1×9 Tablets.

D-ARTEPP® 60 mg / 480 mg:

PA/Alu/PVC-Alu blister. Each blister contains 6 tablets. 1 or 25 such blisters are packed in a box. Pack sizes: 1×6 Tablets

D-ARTEPP® 80 mg / 640 mg

PA/Alu/PVC-Alu blister. Each blister contains 6 tablets. 1 or 25 such blisters are packed in a box. Pack sizes: 1×6 Tablets

6.6 Special precautions for disposal

No special requirements.

Any unused product or waste material should be disposed of in accordance with local requirements.

7. **APPLICANT/HOLDER OF CERTIFICATE OF PRODUCT REGISTRATION**
Tridem Pharma Nigeria Limited Km 4, Ijoko Road, Opposite AP filling station, Junction
Bus stop, Ota, Ogun State, Nigeria.

DRUG PRODUCT MANUFACTURER

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